# Standard Specifications

# for

# Road and Bridge

# Construction

NEVADA DEPARTMENT OF TRANSPORTATION

2014

**NEVADA DEPARTMENT OF TRANSPORTATION**

# Standard Specifications for Road and Bridge Construction


RUDY MALFABON, P.E.
*NDOT Director*

PAUL FROST, P.E.
*Chief Road Design Engineer*

RAYMOND HURLEY, P.E.
*Specifications Engineer*



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**CARSON CITY, NEVADA**

**2014**

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# DIVISION I

# GENERAL REQUIREMENTS

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## SECTION 101

### TERMS AND DEFINITIONS

**101.01 Meaning of Terms.** These specifications are generally written in the imperative mood. In sentences using the imperative mood, the subject, "*the Contractor,*" is implied. For example, when words or phrases such as *"Construct switches with . . . ," "Furnish 3 sets . . . ," "Test the material after . . . ," "Make provisions for . . . ," "Equip the paver with . . . ," "Place the concrete . . . ,"* or any other similar words or phrases are stated, it shall be understood *"The Contractor shall"* perform such work, comply with the requirements of, furnish such material, or take such action. In material specifications, the subject may also be the supplier, fabricator, or manufacturer supplying material, products, or equipment for use on the project.

The words "*shall"* and *"shall be"* are also implied, and when implied or stated are to be considered mandatory and generally pertain to requirements or actions of the Contractor.

Whenever the Contractor is specifically directed or implied by these specifications to "*give notification*" or "*notify,*" it is implied that the Contractor give such notification to the Engineer. Likewise, whenever the specifications state *"notification will be given,"* or *"will be notified,"* it is implied that the Engineer will give such notification to the Contractor.

Whenever anything is, or is to be, done, if, as, or, when, or where "contemplated, required, determined, directed, specified, authorized, ordered, given, designated, indicated, considered necessary, deemed necessary, permitted, reserved, suspended, established, approved, disapproved, acceptable, unacceptable, suitable, accepted, satisfactory, unsatisfactory, sufficient, insufficient, rejected, or condemned," it shall be understood as if the expression were followed by the words "by the Engineer" or "to the Engineer."

The word *"will"* generally pertains to decisions or actions of the Engineer.

**101.02 Abbreviations.** Wherever the following abbreviations are used in these specifications or on the plans, they are to be construed the same as the respective expressions represented:

| | | |
|---|---|---|
| AAN | — | American Association of Nurserymen |
| AASHTO | — | American Association of State Highway and Transportation Officials |
| ACI | — | American Concrete Institute |
| AGC | — | Associated General Contractors of America |
| AISC | — | American Institute of Steel Construction |
| AISI | — | American Iron and Steel Institute |
| ANSI | — | American National Standards Institute |
| ASA | — | American Standards Association |
| ASTM | — | American Society for Testing and Materials |
| AWG | — | American Wire Gauge |
| AWS | — | American Welding Society |
| AWWA | — | American Water Works Association |
| EIA | — | Electronic Industries Association |
| ETL | — | Electrical Testing Laboratories |
| FHWA | — | Federal Highway Administration |
| FSS | — | Federal Specifications and Standards, General Services Administration |
| IES | — | Illumination Engineering Society |
| IMSA | — | International Municipal Signal Association |
| ITE | — | Institute of Transportation Engineers |
| MIL | — | Military Specifications |
| MUTCD | — | Manual on Uniform Traffic Control Devices (for Streets and Highways) |
| NDOT | — | Nevada Department of Transportation |
| NEC | — | National Electric Code |
| NEMA | — | National Electrical Manufacturers Association |

NRS — Nevada Revised Statutes
OSHA — Occupational Safety and Health Administration
QPL — Qualified Products List
RUS — Rural Utilities Service
SI — International System of Units
UL — Underwriters Laboratories, Incorporated

**101.03 Definitions.** Wherever in these specifications or in other contract documents the following terms or pronouns in place of them are used, the intent and meaning shall be interpreted as follows:

**Advertisement.** The public announcement, as required by law, inviting bids for work to be performed or materials to be furnished.

**Approve, Approved, Approval.** Determination of the Engineer that the Contractor's chosen materials or procedures conform to the requirements of the plans and specifications with respect to providing an acceptable and safe project. These terms shall not be construed as a warranty by the Department that the Contractor's methods will succeed or will be the most efficient or economical method of accomplishing the work, nor shall the terms be construed as a warranty that the actual materials used in construction will perform as represented in test results supplied to the Department by the Contractor.

**Award.** The acceptance of a bid by the Department.

**Base Course.** The layer or layers of specified or selected material of designed thickness on a subbase or a sub-grade to support a surface course.

**Bid, Bid Proposal, Proposal.** The offer of a bidder, on the prescribed form, to perform the work and to furnish the labor and materials at the prices quoted.

**Bidder.** An individual, partnership, firm, corporation, or any acceptable combination thereof, or joint venture, submitting a bid for the advertised work.

**Bridge.** A structure, including supports, erected over a depression or an obstruction, such as water, a highway, or railway, and having a track or passageway for carrying traffic or other moving loads and having an opening measured along the center of roadway of more than 6 m (20 ft) between undercopings of abutments or spring lines of arches or extreme ends of openings for multiple boxes for multiple pipes. For multiple pipes to be measured the clear distance between openings shall be less than half of the smaller contiguous opening.

**Bridge Length.** The greater dimension of a structure measured along the center of the roadway between backs of abutment backwalls or between ends of bridge floor.

**Bridge Roadway Width.** The clear width of structure measured at right angles to the center of the roadway between the bottom of curbs or, if curbs are not used, between the inner faces of parapet or railing.

**Calendar Day.** Every day shown on the calendar, beginning and ending at midnight.

**Channel.** A natural or artificial water course.

**Construction Easement.** An acquired right of use over the property of another for the purposes of constructing highway related features outside NDOT right of way limits. Right of use may be temporary in nature (TE) or permanent (PE).

**Contract.** The written agreement between the Department and the Contractor setting forth the obligations of the parties thereunder, including, but not limited to, the performance of the work, the furnishing of labor and materials, and the basis of payment.

The contract includes the invitation to bid, proposal, any subcontractor or DBE/WBE forms, contract form and contract bond, standard specifications, supplemental notice, special provisions, general and detailed plans, notice to proceed, and any change orders and supplemental agreements that are required to complete the construction of the work in an acceptable manner, including authorized extensions and basis of payment thereof, all of which constitute one instrument.

**Contract Bond.** The approved form of security, executed by the Contractor and his surety or sureties, guaranteeing complete execution of the contract and all supplemental agreements pertaining thereto and the payment of all legal debts pertaining to the construction of the project.

**Contract Change Order.** A written order to the Contractor, covering changes in the plans, specifications or quantities, within the scope of the contract, and establishing the basis of payment and time adjustments for the work affected by the changes.

**Contract Item (Pay Item).** An item of work specifically described and for which a price, either unit or lump sum, is provided. It includes the performance of all work and the furnishing of all labor, equipment, and materials described in the text of a specific item included in the contract or described in the standard specifications, supplemental specifications or special provisions, or supplemental notices of the contract. Contract items are numbered so that the first 3 digits of the item number correspond to the Section of the same number. Thus, in Item No. 203 0140, which is the item number for Roadway Excavation, the number 203 is the Section number and corresponds to Section 203 of the Standard Specifications.

Construct each contract item under the specifications contained in the Section of the same number, i.e., the number preceding aforementioned last 4 digits.

**Contractor.** The individual, partnership, firm, corporation, or any acceptable combination thereof, or joint venture, contracting with the Department for performance of prescribed work.

**Contract Time.** Specified time allowed for completion of the contract.

In case a calendar date of completion is shown in the proposal in lieu of the number of working or calendar days, the contract shall be completed by that date.

**Culvert.** Any structure not classified as a bridge which provides an opening under the roadway.

**Day.** Day shall be understood to mean calendar day, unless specified otherwise.

**Department.** The party of the first part to a contract which shall be the Department of Transportation as constituted under the laws of the State of Nevada, for the administration of highway work.

**Detour.** A temporary route for traffic around a closed portion of road.

**Directors.** The directors of the Department of Transportation of the State of Nevada as established by the laws of the State of Nevada, acting directly or through their authorized representatives.

**Disadvantaged Business Enterprise (DBE).** A firm certified by NDOT under Title 49 Code of Federal Regulations Part 26 to participate in the Federal DBE program.

**Divided Highway.** A highway with separated roadways for traffic in opposite directions.

**Employee.** Any person working on the project mentioned in the contract of which these specifications are a part, and who is under the direction and control of, or receives compensation from, the Contractor or his subcontractor.

**Engineer.** The Director of the Department of Transportation of the State of Nevada, acting either directly or through his duly authorized representatives, who is responsible for the engineering supervision of the construction.

**Equipment.** All machinery and equipment, together with the necessary supplies for upkeep and maintenance, and also tools and apparatus necessary for the proper construction and acceptable completion of the work.

**Extra Work.** An item of work not provided for in the contract as awarded but found essential to the satisfactory completion of the contract within its intended scope.

**Frontage Road or Frontage Street.** A local street or road auxiliary to and located generally on the side of an arterial highway for service to abutting property and adjacent areas and for control of access.

**Highway.** A general term denoting a public way for purposes of vehicular travel, including the entire area within the right of way.

**Highway under Construction or Reconstruction.** That portion of a highway being in any part constructed or reconstructed, including those sections of highway between the portion under construction or reconstruction and the pits and the sources of materials approved by the Department for that particular portion of highway under construction or reconstruction.

**Holidays.** In the State of Nevada, these occur on:

January 1 (New Year's Day)
Third Monday in January (Martin Luther King Jr.'s Birthday)
Third Monday in February (Presidents Day)
Last Monday in May (Memorial Day)
July 4 (Independence Day)
First Monday in September (Labor Day)
Last Friday in October (Nevada Day)
November 11 (Veterans' Day)
Fourth Thursday in November (Thanksgiving Day)
Friday following fourth Thursday in November (Family Day)
December 25 (Christmas Day)

or on any day that may be appointed by the President of the United States for public fast, thanksgiving, or as a legal holiday.

If January 1, July 4, November 11, or December 25 falls upon a Sunday, the Monday following shall be observed as a holiday.

If January 1, July 4, November 11, or December 25 falls upon a Saturday, the Friday preceding shall be observed as a holiday.

**Inspector.** The Engineer's authorized representative assigned to make detailed inspections of contract performance.

**Invitation to Bid.** The official notice inviting bids for the proposed work.

**Laboratory.** The testing laboratory of the Department or any other testing laboratory which may be designated by the Engineer.

**Major Contract Item.** A "major item" shall be construed to be any individual bid item included in the proposal that has a total cost equal to or greater than $50,000 or 5% of the total contract cost, whichever is the lesser amount. The total contract cost shall be computed on the basis of the proposal quantities and contract unit prices.

**Materials.** Any substances specified for use in the construction of the project and its appurtenances.

**Materially Unbalanced Bid.** A bid is materially unbalanced if there is a reasonable doubt that award to the bidder submitting a mathematically unbalanced bid will result in the lowest ultimate cost to the Department.

**Mathematically Unbalanced Bid.** A bid is mathematically unbalanced if the bid contains lump sum or unit bid items which do not reflect reasonable actual costs plus a reasonable proportionate share of the bidder's anticipated profit, overhead costs, and other indirect costs.

**Median.** That portion of a divided highway separating the travel ways for traffic generally in opposite directions.

**Notice to Proceed.** A written notice to the Contractor to proceed with the contract work.

**Pavement Structure.** The combination of base course and surface course placed on a subgrade to support the traffic load and distribute it to the roadbed.

**Plans.** The approved project plans and Standard Plans, profiles, typical cross sections, working drawings and supplemental drawings, or exact reproductions thereof, which show the location, character, dimensions and details of the work to be performed. All such documents are to be considered as a part of the plans whether or not noted in the Special Provisions.

In the above definition, these terms are defined as follows:

(a) Standard Plans — The Standard Plans of the Department.

(b) Project Plans — The project plans are specific details and dimensions peculiar to the work and are supplemented by the standard plans insofar as the same may apply.

**Profile Grade.** The trace of a vertical plane intersecting the top surface of the proposed structural section as shown on the plans. Profile grade means either elevation or gradient of such trace according to the context.

**Project.** The specific section of the highway together with all appurtenances and construction to be performed thereon at the prices quoted.

**Proposal Form.** The approved form on which the Department requires bids to be prepared and submitted for the work.

**Proposal Guaranty.** The security furnished with a bid to guarantee that the bidder will enter into the contract if his bid is accepted.

**Right of Way.** A general term denoting land, property or interest therein, usually in a strip, acquired for or devoted to transportation purposes.

**Road.** A general term denoting a public way for purposes of vehicular travel, including the entire area within the right of way.

**Roadbed.** The graded portion of a highway within top and side slopes, prepared as a foundation for the pavement structure and shoulders.

**Roadside.** A general term denoting the area adjoining the outer edge of the roadway. Extensive areas between the roadways of a divided highway may also be considered roadside.

**Roadside Development.** Those items necessary to the complete highway which provide for the preservation of landscape materials and features; the rehabilitation and protection against erosion of all areas disturbed by construction through seeding, sodding, mulching and the placing of other ground covers; such suitable planting and other improvements as may increase the effectiveness and enhance the appearance of the highway.

**Roadway.** The portion of a highway within limits of construction.

**Shoulder.** The portion of the roadway contiguous with the traveled way for accommodation of stopped vehicles, for emergency use, and for lateral support of base and surface courses.

**Sidewalk.** That portion of the roadway primarily constructed for the use of pedestrians.

**Special Provisions.** Additions and revisions to the Standard Specifications covering conditions peculiar to an individual project.

**Specifications.** The directions, provisions, and requirements contained in the Standard Specifications as modified by the Special Provisions. Whenever the term “these specifications” is used in this book, it means the provisions set forth in this book.

**State.** The State of Nevada acting through its authorized representatives.

**Street.** A general term denoting a public way for purposes of vehicular travel, including the entire area within the right of way.

**Structures.** Bridges, culverts, catch basins, drop inlets, retaining walls, cribbing, manholes, end walls, buildings, sewers, service pipes, underdrains, foundation drains, and other features which may be encountered in the work and not otherwise classed herein.

**Subcontractor.** Regardless of license requirements, any individual, partnership, firm, corporation or any acceptable combination thereof, or joint venture, to which the Contractor, with the consent of the Department, sublets any part of the contract.

**Subgrade.** The top surface of a roadbed upon which the pavement structure and shoulders, including curbs, are constructed.

**Substructure.** All of that part of the structure below the bearings of simple and continuous spans, skewbacks of arches and tops of footings of rigid frames, together with backwalls, wingwalls, and wing protection railings.

**Superintendent.** The Contractor's authorized representative in responsible charge of the work, present on the work at all times during the progress to supervise and direct the construction, to receive and fulfill instructions from the Engineer, and to accept orders for changed and extra work.

**Superstructure.** All that part of a structure above the bearings of simple and continuous spans, skewbacks of arches and top of footings of rigid frames; excluding backwalls, wingwalls, and wing protection railings.

**Supplemental Agreement.** A written agreement made and entered into by and between the Contractor and the Department covering work not otherwise provided for, revisions in or amendments to the terms of the contract, or conditions specifically prescribed in the specifications as requiring supplemental agreements. Such supplemental agreements become a part of the contract when approved and properly executed.

**Supplemental Notice.** Additions and revisions to the plans and specifications that are written and issued to prospective bidders after advertisement and before the bid opening.

**Surety.** The corporation, partnership, or individual, other than the Contractor, executing a bond furnished by the Contractor.

**Surface Course.** One or more layers of a pavement structure designed to accommodate the traffic load, the top layer of which resists skidding, traffic abrasion, and the disintegrating effects of climate. The top layer is sometimes called "wearing course."

**Traffic Lane.** The portion of a traveled way for the movement of a single line of vehicles.

**Traveled Way.** That portion of roadway for the movement of vehicles exclusive of shoulders and auxiliary lanes.

**Work.** The furnishing of all labor, materials, equipment, and incidentals necessary or convenient to the successful completion of the project and the carrying out of the duties and obligations imposed by the contract.

**Working Day.** A calendar day on which weather and other conditions not under the control of the Contractor will permit construction operations to proceed for the major part of the day (5 hours) with the normal working force engaged in performing the controlling item or items of work which would be in progress at that time, exclusive, however, of Saturdays, Sundays, State recognized holidays, and any day that is incumbent upon the Contractor, by means of a labor union, to observe as a holiday. However, if the Contractor elects to work on such days, those days will be considered as a working day.

**Working Drawings (Shop Drawings).** Demolition and removal plans, shoring and cofferdam plans, falsework plans, shop fabrication details, erection procedures, prestressing details, and any other supplementary plans or similar data which the Contractor is required to submit to the Engineer for approval.

# SECTION 102

## BIDDING REQUIREMENTS AND CONDITIONS

**102.01 Invitation to Bid.** The Department will give notice of letting of the work. The "Invitation to Bid" will contain a description of proposed work, together with information to the bidder regarding access to the proposal forms, plans, specifications, and the reservation of the right of the Department to reject any or all bids.

**102.02 Prequalification of Bidders.** All bidders shall be prequalified as required by law. To be qualified, submit, under oath, on the standard form furnished by the Department, a statement of your financial ability and experience in the performance of contracts for public work. Attest to the verity of the data submitted by executing the appropriate affidavit which is a part of the "Contractor's Statement of Experience and Financial Condition for Prequalification." After verifying the information contained in the statement, the Department will notify the submitter of the maximum bidding capacity and class of work upon which he will be eligible to bid.

In order to remain on the qualified list, submit a new statement before the expiration of the current prequalification. If not already qualified, submit a statement of financial ability and experience, current within 9 months, at least 5 full days before the date set for the opening of bids in order to have it considered, but qualification will not be granted until such statement has been verified.

No contract will be awarded to a Contractor with a prequalification statement which is not current on the date the contract is awarded.

Nothing contained in this Section shall be construed as depriving the Department of its discretion in the matter of determining the lowest responsible bidder.

On Federal-aid projects, Contractor's pre-qualified by the Nevada Department of Transportation, and their subcontractors, are not required to be licensed in advance of submitting a bid or having such bid considered. Both Contractors and their subcontractors shall have obtained a valid Contractor's license, in accordance with the provisions of NRS Chapter 624, as of the award date of the contract. If a subcontractor is unable to obtain proper licensure prior to the award date, the Contractor may substitute a subcontractor with proper licensure after opening of the bid and prior to the award date. Failure to comply with these licensing requirements by a Contractor or its subcontractor as of the award date will result in the Contractor's bid becoming null and void. Execution of the contract by the Contractor shall be deemed a certification that the licensing requirements have been met. Contractor and subcontractor are encouraged to submit application for licensure to the Nevada State Contractor's Board in advance of contract advertisement.

No bid will be accepted from a Contractor to whom a proposal form has not been issued by the Department.

**102.03 Contents of Proposal Forms.** Upon request, the Department will furnish the prospective bidder with a proposal form. This form will state the location and description of the contemplated construction and will show the approximate estimate of the various quantities and kinds of work to be performed or materials to be furnished, and will have a schedule of items for which unit bid prices are invited. The proposal form will state the time in which the work must be completed, the amount of the proposal guaranty, and the date, time, and place of the opening of proposals. The form will also include any special provisions or requirements which vary from or are not contained in the standard specifications.

All papers bound with or attached to the proposal form are considered a part thereof and do not detach or alter them when submitting the proposal.

The plans, specifications, supplemental notices to contractors and other documents designated in the proposal form will be considered a part of the proposal whether attached or not.

Pay the Department the sum stated in the advertisement and "Invitation to Bid" for each copy of proposal form and each set of plans. The contract documents are nonreturnable and no refund will be made. Make checks in payment for plans and specifications payable to the Nevada Department of Transportation.

The Department will maintain a bidders information list, consisting of information about all firms that bid or quote Department contracts.

(a) Subcontractor Information. Comply with the following requirements:

1. All bidders shall submit information on subcontractors which will be paid an amount exceeding 5% of the total bid on the "NDOT Bidder Subcontractor Information" form provided by the Department, no later than the bid opening time.
2. Within 2 hours after bid opening time, the 3 apparent lowest bidders shall submit information on subcontractors which will be paid an amount exceeding $250,000.00, and on subcontractors which will be paid an amount exceeding 1% of the total bid or $50,000, whichever is greater, on the respective "NDOT Bidder Subcontractor Information" forms provided by the Department.
3. The 3 apparent lowest bidders shall submit information on all subcontractors and suppliers that submitted a proposal to the bidder on the "List of Subcontractors and Suppliers Bidding on NDOT Contracts" form provided by the Department, by 5:00 p.m. local time, on the next business day following the bid opening.
4. All bidders, regardless of their apparent bid ranking, shall submit the "NDOT Bidder Disadvantaged Business or Small Business Enterprise (DBE/SBE) Information" form, as required in Subsection 103.08, no later than the bid opening time. Confirmation letters, required by Subsection 103.08, shall be submitted no later than 5:00 p.m. local time on the next business day following the bid opening.
5. A bidder unable to meet the DBE or SBE goal shall submit documentation which outlines their Good Faith Efforts (GFE) toward meeting the contract goal, as outlined in Subsection 102.16. This information shall be submitted no later than 5:00 p.m. local time on the next business day following the bid opening.
6. A subcontractor named by the bidder who is not properly licensed for that portion of the work will be deemed unacceptable. If the subcontractor is deemed unacceptable, provide an acceptable subcontractor before the award of the contract.
7. All bidders shall affirm all work, other than that being performed by the subcontractors listed in the subcontractor reports, will be self-performed.

Failure to submit any of the subcontractor forms described above, with all required information, within the required time, may deem the bid non-responsive.

**102.04 Interpretation of Quantities in the Proposal.** The quantities given in the proposal and contract forms are approximate only, being given as a basis for the comparison of bids, and the Department does not, expressly or by implication, agree that the actual amount of work will correspond therewith, but reserves the right to increase or decrease the amount of any class or portion of the work, or to omit portions of the work, as may be deemed necessary or advisable.

**102.05 Examination of Plans, Specifications, Contract Documents, and Site of Work.** The Department will prepare plans and specifications giving such directions as will enable any competent contractor to carry them out. Contractors and subcontractors shall carefully examine the site of the proposed work, the proposal, plans, specifications, supplemental specifications, Special Provisions, and contract forms before submitting a proposal. The submission of a bid will be considered prima facie evidence that such examination was made and with satisfaction as to the conditions to be encountered in performing the work and as to the requirements of the plans, specifications, supplemental specifications, Special Provisions, and contract documents.

Direct all questions which may arise as to the interpretation of the plans, specifications, and any other contract documents as required in the "Invitation to Bid." Do not rely upon verbal interpretations given by Department employees in forming bids, but only upon written interpretations provided by an authorized Department employee. Make requests for clarifications no later than the close of business (4:00 p.m. local time) 10 days prior to the scheduled bid opening. Requests made after this date generally will not be addressed.

When a pay item is shown on the plans and not in the proposal, and such pay item is not specifically excluded from payment either in these specifications or in the contract documents, the pay item shall then be considered an obvious omission in the proposal and payment will be made according to Subsection 104.03.

Whenever the Department has obtained subsurface information concerning possible material sources, said information will be included in Section 106.

If foundation reports and boring logs are available, the findings and conclusions presented in said contract documents have been prepared by generally accepted engineering principles and practices. The information shown on the log of test borings applies only at the location of the borings and at the time of drilling. Subsurface conditions may be expected to differ at other locations or to change at these locations with time.

Information derived from inspection of records of subsurface investigations made by the Department will not in any way relieve the Contractor from fulfilling the terms of the contract.

**102.06 Preparation of Proposal.** Submit the proposal as specified in the Invitation to Bid. Specify a unit price in figures for each pay item for which a quantity is given, and show the products of the respective unit prices and quantities, written in figures in the column provided for that purpose, and the total amount of the proposal obtained by adding the amount of the several items. In the event that more than 2 decimal places are used in representing a unit price, all numbers beyond the second decimal will be truncated and the product for the affected item and the total amount of the bid will be recomputed by the Department accordingly. Show all figures in ink or type.

When an item in the proposal contains a choice to be made, indicate the choice in writing, according to the specifications for that particular item, and thereafter no further choice will be permitted.

The bidder's proposal must be signed by the individual, by one or more members of the partnership, by one or more members or officers of each firm representing a joint venture, or by one or more officers of a corporation, or by an agent of the Contractor, legally qualified and acceptable to the Department. If the proposal is made by an individual, show his name and post office address; by a partnership, show the name and post office address of each partnership member; as a joint venture, show the name and post office address of each member or officer of the firms represented by the joint venture; by a corporation, show the name of the corporation and the business address of its corporate officials.

**102.07 Irregular Proposals.** Proposals will be considered irregular and may be rejected for the following reasons:

(a) If the proposal is on a form other than that furnished by the Department, or if the form is altered or any part thereof is detached.

(b) If there are unauthorized additions, conditional or alternate bids, or irregularities of any kind which may tend to make the proposal incomplete, indefinite, or ambiguous as to its meaning.

(c) If the bidder adds any provisions reserving the right to accept or reject an award, or to enter into a contract pursuant to an award.

This does not exclude a bid limiting the maximum gross amount of awards acceptable to any one bidder or at any one bid letting, provided that the selection of any bid awards be made by the Department. See Subsection 102.14.

(d) If the unit prices contained in the proposal are obviously unbalanced, either in excess or below the reasonable cost analysis values.

(e) If the proposal does not contain a unit price for each pay item listed except in the case of authorized alternate pay items.

(f) If the lowest responsive bid exceeds the Engineer's estimate by more than 7%.

Following the opening of bids, the Department will examine the unit bid prices of all bidders for reasonable conformance with the Engineer's Estimate. A bid tabulation including calculated percentage variances from the Engineer's Estimate for each bid item will be forwarded to the Chairman of the Bid Review and Analysis Team (BRAT) for further review.

In determining whether a unit bid price is unbalanced and subject to rejection, the BRAT will consider, but not be limited to, the following criteria:

(a) Mathematically unbalanced bids which are not found to be materially unbalanced may be awarded.

(b) If the quantities as bid are incorrect and the contract cost will be increased when quantities are corrected, the bid may be rejected.

(c) On items where the quantities may vary, if the anticipated variation in quantity would result in the lower bidder not remaining as the low bidder, the bid may be rejected.

(d) If the mathematical unbalancing has a potential detrimental effect upon the competitive process or can cause contract administration problems after the award, the bid may be rejected.

(e) Over pricing items for work done early in the contract (front end loading) could be considered as a materially unbalanced bid, and the bid may be rejected.

Other factors the BRAT will consider in the bid analysis are:

Number of bids.
Distribution or range of bids.
Potential for savings if the contract is readvertised.
Bid prices for the contract under review versus bid prices for similar contracts in the same or recent lettings.
Urgency/effect of delay on the construction of the contract.
Current market conditions/workload.
The significance of the variance of individual unit bid prices from the Engineer's Estimate and if there is any justification for the difference.
Other factors that may be important to the contract.

After review, the BRAT will prepare a report and make one of the following recommendations:

Award to the apparent low bidder.
Award to the apparent second low bidder.
Reject all bids and may readvertise.

**102.08 Proposal Guaranty.** No proposal will be considered unless accompanied by a proposal guaranty, in the amount equal to 5% of the bid, made unconditionally payable to the Nevada Department of Transportation. The guaranty may be cash, cashier's check, certified check, postal money order, bank money order, express money order, bank draft or an undertaking executed by a corporate surety company authorized to do business in the State of Nevada or any other guaranty that may be especially approved by the Department. Such proposal guaranty is to be forfeited to the Department should the bidder to whom the contract is awarded fail to enter into the contract within 20 days after the award.

**102.09 Delivery of Proposals.** Preferably submit paper or flash drive proposals in a special envelope furnished by the Department. Fill in correctly the blank spaces on the envelope to clearly indicate its contents. When an envelope other than the special one furnished by the Department is used, provide one of the same general size and shape and mark similarly to clearly indicate its contents. When sent by mail, address the sealed proposal to the Department at the address and in care of the official in whose office the bids are to be received. All proposals will be filed before the time and at the place specified in the advertisement and "Invitation to Bid." Proposals received after the time for opening of bids will be returned unopened.

**102.10 Withdrawal or Revision of Proposals.** A paper or flash drive proposal may be withdrawn or revised after it has been deposited with the Department, provided the request for such withdrawal or revision is received by the Department, in writing, by fax, or by telegram, before the time set for the opening of bids. The withdrawal of a proposal shall not prejudice the right to file a new proposal provided it is received before the time set for opening of proposals.

Because of the physical limitations of receipt of information by facsimile transmission, there is no guarantee by the Department that the confidentiality of a revision submitted by fax can be maintained, because it is not "sealed" upon receipt. Also, the Department makes no guarantee that a machine will be available to receive such transmission or that telephone lines will be open.

**102.11 Public Opening of Proposals.** Proposals will be opened and read publicly at the time and place indicated in the advertisement and "Invitation to Bid." Bidders, their authorized agents, and other interested parties are invited to be present.

**102.12 Disqualification of Bidders.** Any of the following reasons may be considered as sufficient for the disqualification of a bidder and the rejection of his proposal or proposals:

(a) More than one proposal for the same work from an individual, firm, or corporation under the same or different name.

(b) Evidence of collusion among bidders. Participants in such collusion will receive no recognition as bidders for any future work of the Department until any such participants shall have been reinstated as a qualified bidder.

For Federal-aid projects the U.S. Department of Transportation (DOT) operates a toll-free "hotline," 1-800-424-9071, Monday through Friday, 8:00 a.m. to 5:00 p.m., Eastern Standard Time. Anyone with knowledge of possible bid rigging, bidder collusion, or other fraudulent activities should use the "hotline." All information will be treated confidentially and caller anonymity will be respected.

(c) Unsatisfactory performance record as shown by past work for the Department judged from the standpoint of workmanship and progress.

(d) Uncompleted work which in the judgment of the Department might hinder or prevent the prompt completion of additional work if awarded.

(e) Failure to pay or satisfactorily settle all bills due for labor, equipment, or material on prior or existing contracts.

(f) Failure to hold a valid license of a class corresponding to the work to be done as required by the State Contractor's License Law. However, it is not required to have a Contractor's license in order to bid on Federal-aid projects as long as licensed at time of award of the contract.

(g) Failure to comply with any qualification regulations of the Department.

(h) The FHWA has debarred certain companies and individuals from participation in Federally assisted projects for periods ranging from 6 months to 3 years.

You are advised to contact the Department's Contract Compliance Office, at (775) 888-7497, for the names of the debarred companies and/or individuals before accepting and relying on any quote from any company or individual. The debarred companies or individuals will not be allowed to participate in Federally assisted projects during the period of their debarment.

While this prohibition operates to preclude them from employment as prime contractors, subcontractors, consultants or employees on Federal-Aid projects, the named corporations and individuals may still serve as materials suppliers for prime or subcontractors.

**102.13 Material Guaranty.** The successful bidder may be required to furnish a complete statement of the origin, composition, and manufacture of any or all materials to be used in the construction of the work together with samples, which samples may be subject to the tests provided for in these specifications to determine their quality and fitness for the work.

**102.14 Combination or Conditional Bids.** On certain projects bids may be submitted on more work than is desired to be awarded. Indicate the total amount desired to be accepted and the Department will determine which of the low bids on these projects, up to the final total indicated, will be accepted. This limitation will only apply to those projects on which the following statement has been included in the proposal and is properly filled in.

"We desire to disqualify all of our bids at which in combination exceed the total of $ ..... or ..... contracts and hereby authorize the Department to determine which bids shall be disqualified. Bids have been submitted on the following contract(s) .....as of this date that have not yet been awarded and are to be considered in determining if the above total amount is exceeded."

"A proposal guaranty, conforming to Subsection 102.08, in the amount of $ ..... accompanies the proposal for contract number(s) ..... or has been filed with the Department in advance."

**102.15 Motor Fuel Tax Refund.** It is understood and agreed that the price bid for the work to be done under the contract shall include the applicable tax on motor vehicle fuel and special fuel as required by NRS Chapters 365 and 366.

Determine if subcontractors have reported fuel consumption to the Nevada Department of Motor Vehicles and Public Safety, as required by law.

**102.16 DBE and SBE Certification and Bidding Requirements.** This contract is subject to Title 49, Code of Federal Regulations, Part 26. Portions of those regulations are set forth in these Standard Specifications, and those regulations in their entirety are incorporated herein by this reference.

It is the policy of the Department that Disadvantaged Business Enterprises and Small Business Enterprises as defined in 49 CFR Part 26 and the Department's Disadvantaged Business Enterprise Program shall have an equal opportunity to participate in the performance of contracts financed in whole or in part with Federal funds under this agreement. All the DBE and SBE requirements of 49 CFR Part 26 apply to this agreement.

The Contractor agrees to ensure that DBEs/SBEs have an equal opportunity to participate in the performance of contracts and subcontracts financed in whole or part with Federal funds provided under this agreement. In this regard the Contractor shall take all necessary and reasonable steps in accordance with 49 CFR Part 26 to ensure that DBEs/SBEs have an equal opportunity to compete for and perform contracts.

The Contractor or subcontractor shall not discriminate on the basis of race, color, national origin, or sex in the performance of this contract. The Contractor shall carry out applicable requirements of 49 CFR Part 26 in the award and administration of U.S. Department of Transportation assisted contracts. Failure by the Contractor to carry out these requirements is a material breach of contract, which may result in the termination of this contract or such other remedy as the Department deems appropriate.

DBEs/SBEs must be certified by the Nevada Unified Certification Program (NUCP) in accordance with 49 CFR Part 26. The department is an agency member of the NUCP. A list of certified DBEs/SBEs may be obtained from the Department's website at www.nevadadbe.com.

Certification as a DBE/SBE or a DBE/SBE joint venture shall be predicated on meeting the requirements of 49 CFR Part 26 and the following:

1. The completion and submission of a Disadvantaged Business Enterprise (DBE)/Small Business Enterprise (SBE) Certification Application and all required documents.
2. The submission of any additional documentation requested by the processing Agency.
3. The submission of any additional information which the Department may require to determine the firm's eligibility to participate in the DBE/SBE program.

Applications for certification by the NUCP are available at the Department's Contract Compliance Office, 1263 S. Stewart Street, Carson City, Nevada 89712 and on the Department's website at www.nevadadbe.com.

Applicants submitting a certification application shall agree to permit the Department to audit and examine the books, records, and files of their business.

Applications for certification may be filed with the Department at anytime, however, the firm must be certified at least 5 days prior to bid opening for the project on which the firm seeks to participate to count towards any goals. The Department will process applications in an expeditious manner. The Department will submit applications to the NUCP within 90 days of receiving a completed application and all relevant reference documents.

Bidders shall be responsible for being fully informed about the requirements of the Federal DBE Regulations; particular attention is directed to the following matters:

(a) A DBE/SBE may participate as a prime Contractor, subcontractor, joint venture partner with a prime or subcontractor, or vendor of material or supplies.

(b) A DBE/SBE joint venture partner must be responsible for a clearly defined portion of the work to be performed in addition to satisfying requirements for ownership and control.

(c) A DBE/SBE must perform a commercially useful function.

(d) Credit for a DBE/SBE vendor of materials or supplies is limited to 60% of the price unless the vendor manufactures or substantially alters the goods.

When a DBE/SBE participates in a contract, expenditures toward DBE/SBE goals will only count if the DBE/SBE is performing a commercially useful function on the contract. A DBE/SBE performs a commercially useful function when it is responsible for execution of the work of the contract and is carrying out its responsibilities by actually performing, managing, and supervising the work involved. To perform a commercially useful function, the DBE/SBE shall also be responsible, with respect to materials and supplies used on the contract, for negotiating price, determining quality and quantity, ordering the material, and installing (where applicable) and paying for the material itself. To determine whether a DBE/SBE is performing a commercially useful function, you shall evaluate the amount of work subcontracted, industry practices, whether the amount the firm is to be paid under the contract is commensurate with the work it is actually performing and the DBE/SBE credit claimed for its performance of the work, and other relevant factors.

The value of the work actually performed by the DBE/SBE toward DBE/SBE goals will count according to the following:

1. The entire amount of that portion of a construction contract (or other contract not covered by paragraph number 2 below) that is performed by the DBE's/SBE's own forces will count. The cost of supplies and materials obtained by the DBE/SBE for the work of the contract, including supplies purchased or equipment leased by the DBE/SBE (except supplies and equipment the DBE/SBE subcontractor purchases or leases from the prime contractor or its affiliate) will count.

2. The entire amount of fees or commissions charged by a DBE/SBE firm for providing a bona fide service, such as professional, technical, consultant, or managerial services, or for providing bonds or insurance specifically required for the performance of a DOT-assisted contract, toward DBE/SBE goals, will count provided the fee is determined to be reasonable and not excessive as compared with fees customarily allowed for similar services.
3. When a DBE/SBE subcontracts part of the work of its contract to another firm, the value of the subcontracted work may be counted toward DBE/SBE goals only if the DBE/SBE subcontractor is itself a DBE/SBE. Work that a DBE/SBE subcontracts to a non-DBE/non-SBE firm does not count toward DBE/SBE goals.
4. When a DBE/SBE performs as a participant in a joint venture, a portion of the total dollar value of the contract equal to the distinct, clearly defined portion of the work of the contract that the DBE/SBE performs with its own forces toward DBE/SBE goals will count.

Expenditures for materials or supplies will count toward DBE/SBE goals according to the following:

1. If the materials or supplies are obtained from a DBE/SBE manufacturer, 100% of the cost of the materials or supplies will count. A manufacturer is a firm that operates or maintains a factory or establishment that produces, on the premises, the materials, supplies, articles, or equipment required under the contract and of the general character described by the specifications.
2. If the materials or supplies are purchased from a DBE/SBE regular dealer, 60% of the cost of the materials or supplies will count. A regular dealer is a firm that owns, operates, or maintains a store, warehouse, or other establishment in which the materials, supplies, articles or equipment of the general character described by the specifications and required under the contract are bought, kept in stock, and regularly sold or leased to the public in the usual course of business.

Determination of whether a DBE/SBE trucking company is performing a useful function and the expenditures that count toward DBE/SBE goals will be as follows:

1. The DBE/SBE must be responsible for the management and supervision of the entire trucking operation for which it is responsible on a particular contract, and there cannot be a contrived arrangement for the purpose of meeting DBE/SBE goals.
2. The DBE/SBE must itself own and operate at least one fully licensed, insured, and operational truck used on the contract.
3. The DBE/SBE receives credit for the total value of the transportation services it provides on the contract using trucks it owns, insures, and operates using drivers it employs.
4. The DBE/SBE may lease trucks from another DBE/SBE firm, including an owner-operator who is certified as a DBE/SBE. The DBE/SBE who leases trucks from another DBE/SBE receives credit for the total value of the transportation services the lessee DBE/SBE provides on the contract.
5. The DBE/SBE may also lease trucks from a non-DBE/non-SBE firm, including from an owner-operator. The DBE/SBE who leases trucks from a non-DBE/non-SBE is entitled to credit for the total value of transportation services provided by non-DBE/non-SBE lessees not to exceed the value of transportation services provided by DBE-owned/SBE-owned trucks on the contract (one to one rule for trucking).
6. For trucks leased to the DBE/SBE from either a DBE/SBE or non-DBE/non-SBE firm, the lease must indicate that the DBE/SBE has exclusive use of and control over the truck. This does not preclude the leased truck from working for others during the term of the lease with the consent of the DBE/SBE, so long as the lease gives the DBE/SBE absolute priority for use of the leased truck. Leased trucks must display the name and identification number of the DBE/SBE.

DBE/SBE subcontractors submitted by the prime Contractor as meeting the requirements of this Subsection must have a license, for the type and quantity of work to be performed by said DBE/SBE subcontractor, issued by the appropriate agency prior to the bid opening.

Upon bid submittal, by the prime Contractor, the prime Contractor becomes committed to those certified DBE/SBE firms listed in the bid proposal on the “NDOT Bidder Disadvantaged Business or Small Business Enterprise (DBE/SBE) Information” form.

Verify that all representations made by the Department concerning DBE/SBE subcontractors are in conformance with the State Contractors’ Board Rules and Regulations as well as all other State laws and regulations.

Begin procedures for licensing early enough to insure that DBE/SBE subcontractors are properly licensed prior to the time of the bid opening.

A bidder unable to meet the DBE/SBE goal shall submit documentation which outlines in detail good faith efforts to meet the goal. The bidder must show that it took all necessary and reasonable steps to achieve the goal which, by their scope, intensity, and appropriateness to the objective, could reasonably be expected to obtain sufficient DBE/SBE participation. The efforts employed by the bidder should be those that one could reasonably expect a bidder to take if the bidder were actively and aggressively trying to obtain DBE/SBE participation sufficient to meet the contract goal. Mere pro forma efforts are not good faith efforts to meet the DBE/SBE contract requirements. The Department will consider the quality, quantity, and intensity of the different kinds of efforts that the bidder has made. Some efforts which may be shown are as follows:

(a) Whether the Contractor attended any pre-solicitation or pre-bid meetings that were scheduled by the recipient to inform DBEs/SBEs of contracting and subcontracting opportunities.

(b) Whether the Contractor advertised in general circulation, trade association and minority-focus media concerning the subcontracting opportunities.

(c) Efforts to negotiate with DBEs/SBEs for specific sub-bids including at a minimum:

1. The names, addresses, telephone numbers, and dates the DBEs/SBEs were contacted and the DBEs/SBEs response.
2. A description of the information provided to DBEs/SBEs regarding the plans and specifications for portions of the work to be performed.
3. A statement of why additional agreements with DBEs/SBEs were not reached.

(d) Whether the Contractor followed up initial solicitations of interest by contacting DBEs/SBEs to determine with certainty whether the DBEs/SBEs were interested.

(e) Whether the Contractor selected portions of the work to be performed by DBEs/SBEs in order to increase the likelihood of meeting the DBE/SBE goals (including, where appropriate, breaking down contracts into economically feasible units to facilitate DBE/SBE participation).

(f) Whether the Contractor provided interested DBEs/SBEs with adequate information about the plans, specifications and requirements of the contract.

(g) Whether the Contractor negotiated in good faith with interested DBEs/SBEs, not rejecting DBEs/SBEs as unqualified without sound reasons based on a thorough investigation of their qualifications.

(h) Whether the Contractor made efforts to assist interested DBEs/SBEs in obtaining bonding, lines of credit, or insurance required by the recipient or Contractor.

(i) Whether the Contractor effectively used the services of available minority community organizations; minority contractors' groups; local, State, and Federal minority business assistance offices; and other organizations that provide assistance in the recruitment and placement of DBEs/SBEs.

# SECTION 103

## AWARD AND EXECUTION OF CONTRACT

**103.01 Consideration of Proposals.** After the proposals are opened and read, they will be compared on the basis of the summation of the products of the approximate quantities shown in the proposal by the unit bid prices. The results of such comparisons will be immediately available to the public. In the event of a discrepancy between unit bid prices and extensions, the unit bid prices shall govern.

The right is reserved to reject any or all proposals, to waive technicalities, or to advertise for new proposals, if in the judgment of the Department, the best interests of the State will be promoted thereby.

The Department has determined that the reasonable minimum unit bid price per hour for “flagger” is $20.00 per hour. Any bid proposal which includes Item No. 624 0110, which is for “flagger” measured by the unit of hour, which is less than the minimum amount of $20.00 per hour will be adjusted up to the minimum amount by the Department. The bid item for “flagger” so adjusted will be considered the bidder’s bid and the bidder’s proposal will be recalculated and the revised total used to compare with other bids to determine the lowest responsible bidder. The unit bid price so adjusted is the amount the Department will pay for flagger.

**103.02 Award of Contract.** In order to meet the requirement prescribed under Section 112 (c) of Title 23, United States Code, relative to the award of contracts, furnish with the proposal a sworn statement executed by or in behalf of the person, firm, association or corporation submitting the bid. Provide such sworn statement in the form in the contract documents and sworn to before such persons as are authorized by the laws of the State to administer oaths.

In accordance with the provisions of NRS 338.147 for bidders preference, the Department will award the contract to the lowest responsible bidder with the following exception:

A responsible bidder who at the time of submitting their bid has a valid Certificate of Eligibility to receive a preference in bidding on public works, issued to them by the State Contractor's Board, will be deemed to have submitted a better bid than a competing bidder who does not have such a valid certificate of eligibility if the amount of their bid is not more than 5% higher than the amount bid by the competing bidder.

A copy of the Certificate of Eligibility shall be provided at the time of prequalification, and updated upon renewal of the Certificate. A copy of the Certificate shall be on file with NDOT no later than the Bid Opening time in order to receive a Bidder's Preference.

In addition, a Preference Bidding Certification Affidavit required by NRS 338.147 shall be submitted at the time the contractor submits their bid.

The award of the contract, if it be awarded, will be to the lowest responsible bidder whose proposal complies with all the requirements prescribed. The award, if made, will be made within 60 days after the opening of the proposals. The successful bidder will be notified by letter, mailed to the address shown on his proposal, that his proposal has been accepted and that he has been awarded the contract.

The date of the award of the contract shall be the date of the “Notice of Award.”

**103.03 Cancellation of Award.** The Department reserves the right to cancel the award of any contract at any time before the execution of said contract by all parties without any liability against the Department, except that the Department will reimburse reasonable expenses incurred in reliance upon the “Notice to Proceed.”

**103.04 Return of Proposal Guaranty.** All proposal guaranties, except those of the 2 lowest bidders, will be returned following the checking of bids and the recommendation to award the contract has been approved. The retained proposal guaranties of the 2 lowest bidders will be returned when the contract has been fully executed by the bidder awarded the contract and satisfactory bond has been furnished.

**103.05 Requirement of Contract Bond.** The successful bidder shall, at the time of the execution of the contract, furnish a surety bond or bonds in a sum equal to the full amount of the contract as a guaranty that he will complete the work under the terms of the contract. Such bond, or bonds, shall also provide and secure payment for all materials, labor and supplies, trucks and other means of transportation, used in, or upon, or about, or for the performance of the work contracted to be done, and for any work or labor done thereupon or incidental thereto. The bond or bonds shall be on the form provided in the proposal and shall be written by a surety approved by the Insurance Commissioner of the State of Nevada. In addition, sureties shall have a Best’s rating of “A–” or better according to A. M. Best Company. The power of attorney shall show the limiting amount authorized for issuance of

bonds. Written appointment of agent of bonding company in and for the State of Nevada shall also be licensed, and approved by, the Insurance Commissioner.

If electing to use more than one surety in securing the required performance bond, inform the Department, in writing, what the priority arrangements are between the sureties as well as who the designated lead surety will be. Provide this information at the time the contract is returned to the Department for final execution.

**103.06 Execution and Approval of Contract.** The contract shall be signed by the successful bidder and returned, together with the contract bond, within 20 days after the contract has been mailed to the bidder. If the contract is not executed by the Department within 30 days following receipt from the bidder of the signed contract and bond, the bidder shall have the right to withdraw his bid without penalty. No contract shall be considered as effective until it has been fully executed by all the parties thereto.

**103.07 Failure to Execute Contract.** Failure to execute the contract and file acceptable bonds and/or failure to obtain a valid contractor's license within 20 days after the contract has been awarded shall be just cause for the annulment of the award and the forfeiture of the proposal guaranty which shall become the property of the Department, not as a penalty, but as liquidation of damages sustained. Award may then be made as provided in Subsection 103.02, or the work may be readvertised and constructed under contract or otherwise, as the Department may decide.

**103.08 DBE and SBE Verification and Award Requirements.** The Special Provisions will specify if this Subsection applies to the contract, and if so, will identify the established DBE/SBE participation goal/percentage.

The award of the contract, if it be awarded, shall be to the lowest responsible and responsive bidder meeting the DBE/SBE goals or who has made a good faith effort to do so as outlined in Subsection 102.16.

The DBE/SBE information is subject to verification by the Department which may require additional information or clarification. The DBE/SBE information shall be placed on the "NDOT Bidder Disadvantaged Business or Small Business Enterprise (DBE/SBE) Information" form. Complete the form entirely with all the required information.

Provide written confirmation letters and quotes from each DBE/SBE firm named on the "NDOT Bidder Disadvantaged Business or Small Business Enterprise (DBE/SBE) Information" form to meet the DBE/SBE goal, stating that they agree to perform the work committed to, for the price committed to on the form. This written confirmation must be on the DBE/SBE firm's letterhead and must be received by the Department no later than 5:00 p.m. local time on the next business day following the bid opening.

If it is determined that the bidder has failed to meet the DBE/SBE requirements, the bidder will be provided an opportunity for administrative reconsideration prior to the award of the contract to the next apparent low bidder.

As part of this reconsideration, the bidder will have the opportunity to provide written documentation or argument concerning the issue of whether they met the goal or made adequate good faith efforts to do so.

The decision on reconsideration will be made by an official who did not take part in the original determination that the bidder failed to meet the goal or make adequate good faith efforts to do so.

The bidder will have the opportunity to meet in person with the reconsideration official to discuss the issue of whether it met the goal or made adequate good faith efforts to do so.

A written decision on reconsideration will be sent to the bidder explaining the basis for finding that they did or did not meet the goal or make adequate good faith efforts to do so.

The result of the reconsideration process is not administratively appealable to the Department.

Failure by the Contractor to fulfill the DBE/SBE contract requirements and to demonstrate good faith efforts constitutes a breach of this contract. In such instance, the Department may:

(a) Withhold progress payments or portion thereof;
(b) Deduct as damages an amount equal to the unmet portion of the DBE/SBE commitment not achieved;
(c) Remove the Contractor from the prequalified bidders list for repeated violations;
(d) Suspend and debar for violations, falsifications, or misrepresentations;
(e) Terminate the contract; or
(f) Refer the matter for criminal prosecution.

# SECTION 104

## SCOPE OF WORK

**104.01 Intent of the Contract.** The intent of the contract is to provide for the construction and completion in every detail of the work described. Furnish all labor, materials, equipment, tools, transportation, and supplies required to complete the work according to the plans, specifications, and terms of the contract.

**104.02 Changes in Character of Work and Differing Site Conditions.** (a) Changes. The Engineer reserves the right to make, in writing, at any time during the work, such changes in quantities and such alterations in the work as are necessary to satisfactorily complete the project. Such changes in quantities and alterations shall not invalidate the contract nor release the surety, and the Contractor agrees to perform the work as altered.

The right is reserved to increase or decrease any or all of the items in the estimate of approximate quantities as shown in the proposal. Should any items contained in the proposal be found unnecessary for the proper completion of the work, written order may be given to eliminate such items from the contract, and such action shall in no way invalidate the contract. When a Contractor is notified of the elimination of items, actual work done and all costs incurred will be reimbursed, including mobilization of materials before said notification.

The length of the project may be increased or decreased by adding or omitting sections or by relocation. Under no circumstances shall alterations of plans or of the nature of the work involve work beyond the termini of the proposed construction except as may be necessary to satisfactorily complete the project.

Whenever the termini of the project are changed, a supplemental agreement acceptable to both parties to the contract shall be executed in advance of performing the affected work.

(b) Significant Changes in the Character of Work. If the alterations or changes in quantities significantly change the character of the work under the contract, whether or not changed by any such different quantities or alterations, an adjustment, excluding loss of anticipated profits, will be made to the contract. The basis for the adjustment shall be agreed upon before the performance of the work. If a basis cannot be agreed upon, then an adjustment will be made either for or against the Contractor in such amount as the Engineer may determine to be fair and equitable.

Any such price adjustment will be determined by documented proof of an increase or decrease in actual costs. Documentation for an increase in costs shall include a breakdown showing the basis of the unit bid price.

Failure to give notification in writing of a change in character of work and subsequent performance of said work will be considered as a waiver thereof and payment will be made at the contract unit price for the actual quantity of the work performed. If the alterations or changes in quantities do not significantly change the character of the work to be performed under the contract, the altered work will be paid for as provided elsewhere in the contract.

The term “significant change” shall be construed to apply only to the following circumstances:

1. When the character of the work as altered differs materially in kind or nature from that involved or included in the original proposed construction, or

2. When an item of work is increased in excess of 125% of the original contract quantity and the item of work, after the increase, exceeds a value of $50,000 or 5% of the original contract cost, whichever is the lesser amount, either party to the contract may seek a unit price adjustment. Any allowance due to the increase in quantity shall apply only to that portion in excess of 125% of the original contract item quantity.

3. If a major item of work, decreases below 75% of the original contract quantity, either party to the contract may seek a unit price adjustment. However, the total payment shall not exceed that which would be made for 75% of the original proposal quantity at the contract unit price. Price adjustments for decreases of other than Major Contract Items will not be allowed.

(c) Differing Site Conditions. During the progress of the work, if subsurface or latent physical conditions are encountered at the site differing materially from those indicated in the contract or if unknown physical conditions of an unusual nature, differing materially from those ordinarily encountered and generally recognized as inherent in the work provided for in the contract, are encountered at the site, the party discovering such conditions shall immediately notify the other party in writing of the specific differing conditions before the conditions are disturbed and before the affected work is performed.

Upon written notification, conditions will be investigated, and if determined that the conditions materially differ and cause an increase or decrease in the cost or time required for the performance of any work under the contract, an adjustment, excluding loss of anticipated profits, will be made and the contract modified in writing accordingly. Notification of the determination of whether or not an adjustment of the contract is warranted will be given.

No contract adjustment which results in a benefit to the Contractor will be allowed unless the required written notice is provided.

**104.03 Extra Work.** Perform unforeseen work, for which there is no price included in the contract, whenever it is deemed necessary or desirable in order to complete fully the work as contemplated. Perform such work according to the specifications and as directed, and payment will be made for as agreed unit prices, force account, or a combination of the two. Show agreed unit prices together with the estimated quantities of each unit. Extra work will be paid for according to the executed contract change order or the accepted letter of authorization.

Special Maintenance is work that is not included in the contract but that is defined and ordered by the Engineer to benefit the traveling public. Special Maintenance includes work to maintain and repair damage to existing facilities, except for damage caused by the Contractor. Special Maintenance does not include repair of damage to any improvements constructed by the Contractor and nothing in this paragraph shall be construed to relieve the Contractor of the requirements of Subsection 107.16. Special Maintenance will be paid for as extra work.

**104.04 Rights in and Use of Materials Found on the Work.** Stone, gravel, sand, or other suitable material, as may be found in the excavation, may be used on the project. Payment will be made for both the excavation of such materials at the corresponding contract unit price and also at the contract unit price for the pay item for which the excavated material is used. Replace at own expense with other acceptable material all of that portion of the excavation material so removed and used. Do not excavate or remove any material from within the highway location which is not within the grading limits, as indicated by the slope and grade lines, without written authorization.

The material from any existing old structure may be used temporarily in the erection of the new structure. Do not cut or otherwise damage such material except with approval.

**104.05 Final Clean Up.** Before final acceptance, remove or obliterate, all objects or disturbances of the ground, which mar the landscape and were caused by the construction operations, whether or not part of the improvement. This will be required on all areas used or occupied by the Contractor in connection with the work.

Collect rubbish, excess material, temporary structures, and discarded equipment and dispose of as directed. Do not burn as a method of disposal. Fill pits or trenches for equipment sites and restore the ground, to its original conditions. Scarify and blade temporary haul roads within the right of way limits to blend with surroundings. Dress and shape pits from which materials have been obtained to conform with the surrounding ground and minimize erosion. Remove waste from the tops of banks and place in the bottom of pit. Unless otherwise specified or directed, cut banks of pits to not steeper than 1:3 (3:1) slopes to blend with the natural contours. Grade the bottoms of pits reasonably smooth. Remove or correct all other disturbances as directed. See Subsections 106.02 and 108.09, and Section 201.

# SECTION 105

## CONTROL OF WORK

**105.01 Authority of the Engineer.** The Engineer will decide all questions which may arise as to the quality and acceptability of materials furnished and work performed and as to the rate of progress of the work; all questions which may arise as to the interpretation of the plans and specifications; and all questions as to the acceptable fulfillment of the contract on the part of the Contractor.

The Engineer will have the authority to suspend the work wholly or in part due to: the failure to correct conditions unsafe for the workmen or the general public; the failure to carry out the provisions of the contract; for failure to carry out orders; unsuitable weather; unsuitable conditions for the prosecution of the work; or any other condition or reason deemed to be in the public interest.

The Engineer has executive authority to enforce orders and his decision will be final. In the event of failing to execute work ordered within a reasonable period of time, the Engineer may, after giving notice in writing, proceed to have such work performed as deemed necessary and the cost thereof will be deducted from compensation due or which may become due.

Decisions of the Engineer shall be final and conclusive. Make any appeal in writing and within 10 days of the Engineer's decision, but in the meantime diligently proceed with the work.

**105.02 Plans and Working Drawings.** Plans will show location and general details of structures, lines, grades, typical cross sections of the roadway, and a summary of items appearing on the proposal. Keep one set of plans available on the work at all times.

Supplement plans with working drawings (shop drawings) as necessary to adequately control the work. Furnish working drawings for structures including, but not limited to; demolition and removal plans, shoring and cofferdam plans, falsework plans, shop fabrication details, erection procedures, prestressing details, and other required information specified herein. Unless otherwise specified, submit 6 sets of working drawings for review and approval a minimum of 30 days before start of related work. Submit the working drawings a minimum of 90 days before start of related work which is within Railroad right of way. Additional contract time will not be given for working drawings requiring changes and re-submittal. Approval of working drawings shall not operate to relieve the responsibility under the contract for the successful completion of the work. It is mutually agreed that the Contractor shall be responsible for agreement of dimensions and details as well as for conformity of his working drawings with the approved plans and specifications.

For English unit contracts, furnish working drawings in English units or both English and metric units. For metric unit contracts, furnish working drawings in metric units or both metric and English units. For working drawings which require Railroad approval, furnish the working drawings in English units only.

The contract price will include the cost of furnishing all working drawings.

**105.03 Conformity with Plans and Specifications.** Perform work and furnish materials in reasonably close conformity with the lines, grades, cross sections, dimensions, and materials requirements, including tolerances, shown on the plans or indicated in the specifications.

If the materials or the finished product in which the materials are used are found not within reasonably close conformity with the plans and specifications but that reasonably acceptable work has been produced, then a determination will be made if the work will be accepted and may remain in place. In this event, the basis of acceptance will be documented by contract modification which will provide for an appropriate adjustment in the contract price for such work or materials as deemed necessary to conform to the determination based on engineering judgment.

If the materials or the finished product in which the materials are used or the work performed are found not in reasonably close conformity with the plans and specifications and have resulted in an inferior or unsatisfactory product, remove and replace or otherwise correct the work or materials.

**105.04 Coordination of Plans, Specifications, Supplemental Specifications, and Special Provisions.** The specifications, supplemental specifications, plans, Special Provisions, and all supplementary documents are essential parts of the contract, and a requirement occurring in one is as binding as though occurring in all. They are intended to be complementary and to describe and provide for a complete work. In case of discrepancy, calculated

dimensions will govern over scale dimensions; plans will govern over specifications; supplemental specifications will govern over specifications; Special Provisions will govern over both specifications and plans.

Take no advantage of any apparent error or omission in the plans or specifications. In the event of the discovery of such an error or omission, immediately give notification. Such corrections and interpretations will then be made as may be deemed necessary for fulfilling the intent of the plans and specifications.

**105.05 Partnering.** For the benefit of both the Contractor and the Department, the formation of a "Partnering" relationship will be established in order to effectively complete the contract. The purpose of this relationship is to maintain cooperative communication and mutually resolve conflicts at the lowest responsible management level.

The Department strives to work cooperatively with all contractors and partnering is our way of doing business. The Department encourages partnering utilizing a partnering team. The partnering team consists of significant contributors from the Contractor, Department, and invited stakeholders.

For contracts with a total bid up to $10 million, professionally facilitated partnering is encouraged. For a contract with a total bid greater than $10 million, professionally facilitated partnering is required.

The establishment of the Partnering relationship will not change or modify the terms and conditions of the contract.

A written invitation to enter into a partnering relationship will be sent after contract award. Respond within 15 days to accept the invitation and request the initial and additional partnering workshops. After the Engineer receives the request, the Contractor and the Engineer shall cooperatively select a partnering facilitator that offers the service of a monthly partnering evaluation survey, schedule the initial partnering workshop, select the initial workshop site and duration, and agree to other workshop administrative details.

Additional quarterly partnering workshops will be required throughout the life of the contract.

When requested by either party, a partnering trainer will conduct a 1-day training session in partnering skills development for Contractor and Department representatives before the initial partnering workshop.

The Contractor and the Engineer will cooperatively schedule the training session, obtain a professional trainer, and select a training site.

This training session shall be a separate session from the initial partnering workshop and shall be conducted locally.

In implementing partnering, the Contractor and the Engineer shall manage the contract by:

1. Using early and regular communication with involved parties.
2. Establishing and maintaining a relationship of shared trust, equity, and commitment.
3. Identifying, quantifying, and supporting attainment of mutual goals.
4. Developing strategies for using risk management concepts.
5. Implementing timely communication and decision making.
6. Resolving potential problems at the lowest possible level to avoid negative impacts.
7. Holding periodic partnering meetings and workshops as appropriate to maintain partnering relationships and benefits throughout the life of the contract.
8. Establishing periodic joint evaluations of the partnering process and attainment of mutual goals.

The partnering team shall create a team charter that includes mutual goals (core project goals which may also include project specific goals and mutually supported individual goals), a partnering maintenance and closeout plan, dispute resolution plan with a dispute resolution ladder, and team commitment statement and signatures.

The partnering team shall participate in monthly partnering evaluation surveys to measure progress on mutual goals and short-term key issues as they arise, hold a contract closeout partnering session, and document lessons learned before contract acceptance.

The Department encourages the partnering team to exhaust the use of partnering in dispute resolution and the use of the escalation ladder for dispute resolution. Whenever a dispute cannot be resolved by the use of the partnering process, the provisions of Subsection 105.18 will remain in effect except the notification required under Subsection 104.02 will be satisfied by the completion of the "Conflict Resolution Form."

The costs for providing the Partnering Facilitator, Partnering Trainer, and Workshop Sites will be borne by the Department. The Contractor shall pay all initial costs incurred. The Department will reimburse the Contractor all of the costs as evidenced by copies of invoices from the Facilitator, Trainer, and Workshop Site provider. Markup or profit added to invoices will not be allowed. All other costs associated with Partnering shall be borne separately by the party incurring the cost.

**105.06 Cooperation by Contractor.** A minimum of 4 sets of approved plans and contract assemblies including Special Provisions will be supplied. Additional copies of plans and Special Provisions may be obtained upon written request to the Department, for which payment may be required.

Give the work constant attention necessary to facilitate the progress thereof, and cooperate with the Engineer, his inspectors, and other contractors in every way possible.

Have on the work at all times, as your agent, a competent superintendent capable of reading and thoroughly understanding the plans and specifications and thoroughly experienced in the type of work being performed, who shall receive instructions from the Engineer. Designate such superintendent in writing before starting work. The superintendent shall have full authority to execute orders or directions of the Engineer without delay, and to promptly supply such materials, equipment, tools, labor, and incidentals as may be required. Furnish such superintendence irrespective of the amount of work sublet.

Whenever the Contractor or his authorized representative is not present on any particular part of the work where it may be desired to give direction, orders will be given by the Engineer to the Contractor's superintendent, foreman, or other person in charge of the operation, who is present, and these orders shall have the same force and effect as if given to the Contractor or his designated representative.

Any order given by the Engineer, not otherwise required by the specifications to be in writing, will on request be given or confirmed in writing.

**105.07 Cooperation with Utilities.** The Department will notify all utility companies, all pipeline owners, or other parties affected, and endeavor to have all necessary adjustments of the public or private utility fixtures, pipelines, and other appurtenances within the limits of construction, made as soon as practicable.

Water lines, gas lines, wire lines, service connections, water and gas meter boxes, water and gas valve boxes, light standards, cable ways, signals, and all other utility appurtenances within the limits of the proposed construction which are to be relocated or adjusted are to be moved by the owners at their expense, except as otherwise provided for in the Special Provisions or as noted on the plans.

Possible underground facilities may exist that are not known to the State or in a location different from that which are shown on the plans or in the Special Provisions. Take steps to ascertain the exact location of all underground facilities before doing work that may damage such facilities or interfere with their service. The locating of underground facilities is the sole responsibility of the Contractor. No reliance may be placed upon the location of underground facilities as noted on the plans.

Where it is determined by the Engineer that the rearrangement of an underground facility, the existence of which is not shown on the plans or in the Special Provisions, is essential in order to accommodate the highway improvement, the rearrangement of such facility will be provided for by other forces or by the Contractor as extra work as provided in Subsection 104.03.

Any delays to the Contractor's operations as a direct result of utility or other nonhighway facilities not being rearranged as herein provided (other than delays in connection with rearrangements made to facilitate construction operations) will be considered right of way delays within the meaning of Subsection 108.12.

Compensation for such delay will be determined according to Subsection 108.12, and no further compensation will be allowed therefore. See Subsection 107.17.

**105.08 Cooperation Between Contractors.** The Department reserves the right at any time to contract for and perform other or additional work on or near the work covered by the contract.

When separate contracts are let within the limits of any one project, each Contractor shall conduct his work so as not to interfere with or hinder the progress or completion of the work being performed by other Contractors. Contractors working on the same project shall cooperate with each other as directed. Join work with that of the others in an acceptable manner and perform it in proper sequence to that of the others. In the event of concurrent

work, coordinate operations with the other Contractors in such a manner that all requirements, restrictions, and stipulations specified in the contract documents are met.

Each Contractor involved shall assume all liability, financial or otherwise, in connection with his contract and shall protect, indemnify, defend, and hold harmless the Department from any and all damages or claims that may arise because of inconvenience, delay, or loss experienced by him because of the presence and operations of other Contractors working within the limits of the same project.

**105.09 Construction Stakes, Lines, and Grades.** Construction stakes establishing lines, slopes, and continuous profile-grade in road work, and centerline and bench marks for bridge work, culvert work, protective and accessory structures and appurtenances will be set as deemed necessary, and all necessary information relating to lines, slopes, and grades will be furnished. These stakes and marks shall constitute the field control by and in under which the Contractor shall establish other necessary controls and perform the work.

Preserve construction stakes and marks. If any of the construction stakes or marks have been carelessly or willfully destroyed or disturbed by the Contractor, the cost of replacing them will be charged against him and will be deducted from the payment for the work.

The Department will be responsible for the accuracy of line, slopes, grades, and other engineering work which is set forth under this Section.

After initial slope staking of horizontal and vertical controls, give 72 hours written notice for any additional required controls. Saturdays, Sundays, and holidays will not be counted as part of the 72 hours.

**105.10 Authority and Duties of the Resident Engineer.** As the direct representative of the Director of the Department of Transportation, the Resident Engineer has immediate charge of the engineering details of each construction project. The Resident Engineer is responsible for the administration and satisfactory completion of the project. The Resident Engineer shall have the authority to reject defective materials and to suspend any work that is being improperly performed.

**105.11 Duties of the Inspector.** Inspectors employed by the Department will be authorized to inspect all work done and all materials furnished. Such inspection may extend to all or any part of the work and to the preparation, fabrication or manufacture of the materials to be used. The inspector will not be authorized to alter or waive the provisions of the contract. The inspector will not be authorized to issue instructions contrary to the plans and specifications, or to act as foreman for the Contractor; however, the inspector shall have the authority to reject work or materials until any questions at issue can be referred to and decided by the Engineer.

**105.12 Inspection.** All materials and each part or detail of the work shall be subject to inspection by the Engineer. Provide the Engineer acceptable access to all parts of the work and furnish him with such information and assistance as required to make a complete and detailed inspection.

If requested, at any time before final acceptance of the work, remove or uncover such portions of the finished work as may be directed. After examination, restore said portions of the work to the standard required by the specifications. Should the work thus exposed or examined prove acceptable, the uncovering, or removing and the replacing of the covering, or making good of the parts removed will be paid for as extra work according to Subsection 104.03; but should the work so exposed or examined prove unacceptable, the uncovering, or removing and replacing of the covering, or making good of the parts removed will not be paid for.

Any work done or materials used without inspection by the Engineer may be ordered removed and replaced at own expense, unless the Engineer failed to inspect after having been given reasonable notice in writing that the work was to be performed.

When facilities of any unit of government, political subdivision, railroad corporation, or public utility corporation are adjusted or constructed as a part of the work covered by this contract, its respective representatives shall have the right to inspect the work. Such inspection shall in no sense make any unit of government, political subdivision, railroad corporation, or public utility corporation a party to this contract, and shall in no way interfere with the rights of either party thereunder.

**105.13 Removal of Unacceptable and Unauthorized Work.** Work which does not conform to the requirements of the contract will be considered as unacceptable work, unless otherwise determined acceptable under the provisions in Subsection 105.03.

Immediately remove and replace unacceptable work, whether the result of poor workmanship, use of defective materials, damage through carelessness, or any other cause, found to exist before the final acceptance of the work in an acceptable manner.

Work done contrary to the instructions of the Engineer, work done beyond the lines shown on the plans, or as given, except as herein specified, or any extra work done without authority, will be considered as unauthorized and will not be paid for under the provisions of the contract. Work so done may be ordered removed or replaced at own expense.

Upon failure to comply forthwith with any order of the Engineer, made under the provisions of this Subsection, the Engineer will have authority to cause unacceptable work to be remedied or removed and replaced and unauthorized work to be removed and to withhold the costs from any money due or to become due.

**105.14 Load and Speed Restrictions.** Do not damage the work when hauling.

When hauling material for incorporation in portions of highways under construction or reconstruction, hereinafter called the project, do not haul loads which are in excess of the limits set by the Department on any new or existing bridge or new and existing bituminous base and surface, cement treated base, or Portland cement concrete paving which is to remain in place for vehicular traffic within the project or between the project and the material deposits or other sources of materials. Comply with load limits established by the Department for the project regardless of the source of materials, whether from designated or nondesignated deposits or approved commercial sources. Unless otherwise permitted in writing, do not exceed the maximum loads limits set forth in NRS Chapter 484.

The Engineer may, for the protection of the traveling public, establish speed limits on or adjacent to the project. Strictly observe such limitations of speed.

Reduce truck loads in excess of 450 kg (1,000 lb) of the maximum gross mass to the legal mass immediately after weighing and before hauling to the placement site. For failure to reduce the load and subsequent hauling of it to the placement site, a 50% reduction in the contract unit price bid for that load will be made, not as a penalty, but as liquidated damages.

Gross construction vehicle weight in excess of legally permitted highway loads will not be allowed on any portion of the cement treated base, roadbed modified base, Portland cement concrete pavement, cold milled bituminous surface, or any new or existing base or surface which may become damaged.

**105.15 Maintenance During Construction.** Maintain the contract work during construction and until the project is accepted, except as provided for in Subsection 107.15. This maintenance shall constitute continuous and effective work prosecuted day by day, with adequate equipment and forces so that the roadway and structures are at all times kept in a satisfactory condition. Take maintenance responsibility for any work performed or to be performed under the contract. Correct or repair all damage attributable to Contractor's operations.

In the case of a contract for the placing of a course upon a course or subgrade previously constructed, maintain the previous course or subgrade during all construction operations.

Except as provided for in Subsection 107.15, include all costs of maintenance work during construction and before the project is accepted in the unit prices bid on the various pay items and an additional payment will not be made for such work.

Immediate notification will be given in writing for failure to comply with these provisions. If failing to remedy unsatisfactory maintenance within 24 hours after receipt of such notice, the Engineer may immediately proceed to maintain the project, and the entire cost of this maintenance will be deducted from money due or to become due.

**105.16 Final Inspection and Acceptance.** Upon due notice or presumptive completion of the entire project, inspection will be made and if all construction and final cleanup provided for and contemplated by the contract is found satisfactorily completed, that inspection shall constitute the final inspection. See Subsection 104.05.

If, however, the inspection discloses any work, in whole or in part, as being unsatisfactory, necessary instructions will be given for correction of same, and immediately comply with and execute such instructions.

Upon correction of the work, another inspection will be made which shall constitute the final inspection provided the work has been satisfactorily completed. In such event, notification will be given in writing and the Department will

assume maintenance responsibilities for the project as of the date of final inspection.

After final inspection has been established as provided above, the publication of a notice of the date of final acceptance of the contract will be made.

For contracts in Clark County, final acceptance will not be made until a copy of the final inspection and release from the Clark County Department of Air Quality Management has been provided, as specified in Section 637.

**105.17 Requests for Equitable Compensation and Adjustments.** If, believing that additional compensation is due for work or material not clearly covered in the contract or not ordered as extra work as defined herein, give notification in writing of intention to request additional compensation before beginning the work on which basing the request. If such written notification is not given, and the Engineer is not afforded proper facilities by the Contractor for keeping strict account of actual cost as required, then the Contractor shall be deemed to waive any rights for such additional compensation. Such notice and the accounting of the cost as aforesaid, shall not be construed as proving or substantiating the validity of the request. If the request is found to be just, it will be paid pursuant to Subsection 104.03.

Subcontractor requests will not be considered except as submitted and certified by the Contractor as the Contractor's request.

For all requests originating with a Subcontractor, thoroughly evaluate the request and either admit or deny its validity in a statement sworn to under oath. If denying the request, do not present the request to the Department. If the Subcontractor sues the Contractor for payment, the Contractor shall not sue the Department for indemnity, contribution, or under any other theory for participation in the payment of the Subcontractor's request. The Contractor specifically acknowledges that Subcontractor requests are the Contractor's responsibility, and that they are contractually obligated not to involve the Department in such request as they believe are not valid.

For all requests, certify in writing that the request is made in good faith, that the supporting data are accurate and complete to the best of knowledge and belief, and that the amount requested accurately reflects the contract adjustment for which the Department is believed liable.

By signing the Contract, the Contractor agrees to waive all rights to any requests for additional compensation not submitted within one year of the date of the Director's acceptance.

**105.18 Disputes Review Team.** A Disputes Review Team (DRT) will be established to assist in the resolution of disputes, claims, and other controversies arising out of the work of the contract.

The DRT will assist in, and facilitate, the timely and equitable resolution of disputes between the Engineer and the Contractor in an effort to avoid construction delay and litigation.

The intent is that the DRT be utilized only after the partnering dispute resolution process has been exhausted. It is intended that the DRT encourage the Engineer and Contractor to resolve potential disputes without resorting to the hearing of disputes by the DRT. It is not intended for the Engineer or the Contractor to default on their normal responsibility to amicably and fairly settle their differences by indiscriminately assigning them to the DRT.

Either the Engineer or the Contractor may request a dispute be heard by the DRT. Such a request may be made as soon as it appears that the partnering dispute resolution process is not succeeding. The DRT shall fairly and impartially consider disputes referred to it, and shall provide written recommendations to the Engineer and the Contractor, to assist in the resolution of these disputes.

Although the recommendations of the DRT should carry great weight for both the Engineer and the Contractor, they are not binding on either Party.

If the DRT recommendation does not resolve the dispute, the written recommendation, including any minority report, will be admissible as evidence, to the extent permitted by law, in any subsequent proceeding or forum to establish: (a) that a DRT considered the Dispute; (b) the qualifications of the DRT members; and (c) the DRT recommendation that resulted from the process.

At all times during the course of the dispute resolution, the Contractor shall continue with the work as directed, in a diligent manner and without delay, or shall conform to the Engineer's decision or order, and shall be governed by all applicable provisions of the contract. Records of the work shall be kept in sufficient detail to enable payment in accordance with applicable provisions in the contract.

The DRT will consist of one member selected by the Engineer and approved by the Contractor, one member selected by the Contractor and approved by the Engineer, and a third member selected by the first two members and approved by both the Engineer and the Contractor. Normally, the third member will act as Chairman for all DRT activities.

DRT members may be proposed from a variety of sources including, but not limited to, industry experts, engineering experts, the American Arbitration Association, and the Dispute Resolution Board Foundation.

The purpose of the DRT is to provide knowledgeable expertise to assist in avoiding and resolving construction conflicts. Toward that purpose, each of the first two members should be acknowledged and experienced experts in the means, methods, and practices of Engineering and construction in the type of construction involved in the project. The goal in selecting the third member is to act as chairman of the DRT and provide leadership for the DRT's activities.

The DRT members shall show no partiality to either the Contractor or the Engineer; or have any conflict of interest. Before their appointments are final, the first two prospective members shall submit complete disclosure statements for the approval of both the Engineer and the Contractor. Each statement shall include a resume of experience together with a declaration describing all past, present, and anticipated or planned future relationships to the contract and with all Parties involved in the construction contract. Disclosure of recent, close, professional, or personal relationships with all key members of all Parties to the contract shall be included. The third DRT member shall supply such a statement to the first two DRT members and to the Engineer and Contractor before his/her appointment is final. The Engineer and the Contractor shall each have the opportunity to interview any prospective DRT member before their appointment is final.

If a DRT is established as provided for herein, the Engineer, Contractor, and all three members of the DRT shall execute the Disputes Review Teams Controlling Document (DRT Controlling Document) within six weeks after the selection of the third member. Contact the Department’s Construction Division for a copy of the DRT Controlling Document.

The DRT shall operate in accordance with the DRT Controlling Document.

Disputes shall be considered as quickly as possible, taking into consideration the particular circumstances and the time required to prepare detailed documentation. Steps in the procedure for dispute resolution may be omitted as agreed to by both parties in writing, and the time periods stated in the DRT Controlling Document may be shortened to hasten resolution.

"Allowable DRT Costs" are the actual invoice costs for the Team, including the DRT members' expenses, and facilities cost, for DRT meetings. Contractor’s labor, overhead, and profit are not Allowable DRT Costs. The Engineer and the Contractor shall share equally the Allowable DRT Costs associated with the DRT, including, but not limited to, costs and expenses of the hearing and DRT members' time billed for considering a dispute. These costs will be the actual invoiced cost and include no markup.

The Contractor shall pay all fees and expenses associated with the DRT and may bill and thereafter be reimbursed for one half the costs by the Department for all Allowable DRT Costs which the Engineer is responsible for as determined above.

Payment for members' services shall be as provided in the DRT Controlling Document. The Engineer will provide administrative services associated with assembly of and communication with the DRT, and will solely bear the costs of these Engineer services.

**105.19 Value Engineering Proposals.** Value Engineering Proposals (VEP) may be submitted in writing for modifying the plans, specifications, or other requirements of the contract for the purpose of reducing the total cost of construction without reducing design capacity or quality of the finished product. The proposal must be submitted as such to allow timely review by the Department before commencing work. If accepted, net savings resulting from a VEP will be shared by the Department and the Contractor on a 50-50 basis.

The requirements herein apply to all VEPs initiated and developed by the Contractor and which are identified as such at the time of submission. Nothing herein shall be construed as requiring consideration or approval of a VEP submitted hereunder.

Each VEP shall result in a net savings over the contract costs without impairing essential functions and characteristics of the item(s) or of any other part of the project, including but not limited to environmental

considerations, service life, reliability, economy of operation, ease of maintenance, desired aesthetics, and safety.

Submit the following information with each VEP:

(a) A statement that the proposal is submitted as a VEP;

(b) A statement concerning the basis for the VEP and benefits to the Department together with an itemization of the contract requirements affected by the VEP;

(c) A detailed estimate of the cost under the existing contract and under the VEP;

(d) Proposed specifications and recommendations as to how such VEP changes are to be accomplished; and

(e) A statement as to the time by which a contract change order adopting the VEP must be issued so as to obtain the maximum cost effectiveness.

The VEP will be processed in the same manner as prescribed for any other proposal which would necessitate issuance of a contract change order. The Department may accept in whole or in part any VEP by issuing a contract change order which will identify the VEP on which it is based. The Department will not be liable for failure to accept or act upon any VEP submitted pursuant to these requirements nor for any delays to the work attributable to any such proposal. Until a proposal is effected by contract change order, remain obligated to perform under the terms and conditions of the existing contract. If an executed contract change order has not been issued by the date upon which the proposal specifies that a decision thereon should be made, or such other date as the Contractor may have subsequently specified in writing, such proposal shall be deemed rejected.

The contract change order effecting the necessary contract modification will establish the net savings agreed upon, will provide for adjustment in the contract prices, and will indicate the new savings to be equally divided between the Contractor and the Department. Absorb all costs incurred in preparing a VEP for submission. All reasonably incurred costs of reviewing and administering the VEP will be borne by the Department. The Department reserves the right to include in the agreement any conditions it deems appropriate for consideration, approval, and implementation of the proposal. The Contractor's 50% share of the net savings shall constitute full compensation to him for effecting all changes pursuant to the agreement.

Acceptance of the VEP and performance of the work thereunder will not change the contract time limit as a result of the VEP, unless specifically provided for in the contract change order authorizing the VEP.

The Department expressly reserves the right to adopt a VEP for general use in contracts administered by the Department when it determines that said proposal is suitable for application to other contracts. VEPs identical or similar to previously submitted proposals will be eligible for consideration and compensation under these provisions if such proposals were not previously adopted for general application to other contracts administered by the Department. When a VEP is adopted for general use, compensation pursuant to these requirements will be applied only to those contracts awarded and for which the subject VEP has been submitted before the date of adoption of the specific VEP.

Proposed changes in the basic design of a bridge or pavement type, traffic control plan, or changes which require different right of way limits, will not normally be considered as an acceptable VEP.

The elimination or changes to the required marination of plantmix bituminous aggregates will not be considered as an acceptable VEP.

The Engineer shall be the sole judge of the acceptability of a VEP.

Subject to the provisions contained herein, the Department or any other public agency shall have the right to use all or part of any accepted VEP without obligation or compensation of any kind to the Contractor.

In the event a VEP is accepted by the Department, the provisions of Subsection 104.02 which pertain to adjustment of contract unit prices due to alterations of contract quantities will not apply to items adjusted or deleted as a result of effecting the VEP by contract change order.

# SECTION 106

## CONTROL OF MATERIAL

**106.01 Source of Supply and Quality Requirements.** Furnish all materials required to complete the work, except materials that are designated in the Special Provisions to be furnished by the Department as specified in Subsection 106.11.

Only incorporate materials conforming to the requirements of the specifications in the work.

Furnish and use new materials unless otherwise specified. Manufacture, handle and use materials in a workmanlike manner to ensure completed work according to the plans and specifications.

Give notification of proposed sources of material a minimum of 30 days in advance of their use to enable the Engineer to properly inspect, sample, and test said sources of material.

If it is found after trial that sources of supply for previously approved materials do not produce uniform and satisfactory products, or if the product from any source proves unacceptable at any time, furnish satisfactory materials from other sources.

Furnish without charge such samples as may be required. Inspection and tests will be made, but it is understood that such inspections and tests, if made at any point other than the point of incorporation in the work, in no way shall be considered as a guarantee of acceptance of such material nor of continued acceptance of material presumed to be similar to that upon which inspections and tests have been made.

Reports and records of inspections made and tests performed may be examined.

Deliver manufacturer's warranties, guarantees, instruction sheets, and parts lists, which are furnished with certain articles or materials incorporated in the work, before acceptance of the contract.

Do not use materials that are past the expiration date or have exceeded the shelf life indicated in the manufacturer's technical data sheets.

A Qualified Products List (QPL) may be obtained from NDOT Administrative Services, 1263 S. Stewart Street, Carson City, Nevada 89712, phone (775) 888-7070. The QPL is a list of manufactured products available on the market that have been evaluated and determined suitable for a specified use. The Spec Number in the QPL corresponds to the Subsection in the Standard Specifications or the Special Provisions where the item is specified. The Contractor's procurement and use of products is limited to those listed in the QPL or to those products meeting current specifications. Submit sufficient product information with any request for approval to use a product other than those listed.

Products listed in the QPL shall be restricted to use in the category in which they are listed and shall be installed as recommended by the manufacturer. Replace any qualified products not conforming to specifications, or which are improperly handled or installed.

**106.02 Local Materials.** Local material is rock, soil, or other mineral material, including borrow, selected borrow, or other selected material, obtained or produced from sources in the vicinity of the work specifically for use on the project.

Furnish local materials from any source, except when a mandatory source is designated in the Special Provisions.

Contact the Nevada Division of Environmental Protection (NDEP) to obtain a Change of Location Application (COLA) prior to entry into any material site that the Department has an application with the BLM for the rights to mine materials. A COLA will not be issued for any Department furnished source until the apparent low bidder has been confirmed by NDEP.

Imported material shall comply with Federal, State, or local regulations and requirements. Material imported for use shall not originate from an uncontrolled hazardous waste site, or similar site as defined by Federal, State, or local regulation or definition, unless it meets necessary Federal, State, or local regulations and agency determinations. Contaminated, regulated, or hazardous materials, as defined by Federal, State, or local regulation or definition, shall not be imported for use.

Do not excavate material deposits where the resulting scars will present an unsightly appearance from any highway, unless such deposit is approved in writing.

Do not encroach pit operations within 7.6 m (25 ft) of highway right of way.

The following requirements shall apply to all material sites used on the project regardless of whether such material sites are located on private or public lands:

(a) Before removing any material for construction purposes, strip and stockpile the top 150 mm (6 in.) of material in such a manner that it may later be used to cover the excavated area as directed in subparagraph (c) below.

(b) Before completion of the project, reclaim the area disturbed by use on this project by scarifying/ripping/tilling the entire disturbed area, then recontouring the slopes to a maximum 1:3 (3:1) gradient. Grade the bottom or floor of the excavated area to present a neat and uniform appearance, with no areas subject to ponding water. Perpetuate natural drainage and cover all disturbed areas with the stockpiled topsoil.

(c) Place aggregate waste (except for brush removed from the deposit area) resulting from operations in the deposit area on the floor of the deposit area and shape to blend therewith. Do not place material containing bituminous products in the deposit area. After all waste material has been placed on the floor of the pit and the sides and bottom of the excavated area have been shaped as specified, uniformly distribute the material excavated and stockpiled as required in subparagraph (a) over the entire excavated area in such a manner that the area will present a satisfactory neat and uniform appearance. Mulch and mix brush removed from the deposit area with the top 150 mm (6 in.) of material as it is spread over the deposit area or otherwise dispose of said brush in a satisfactory manner. Do not burn brush. Reseed the newly replaced topsoil with a native plant seed mix, which is noxious weed free and approved by the Bureau of Land Management (BLM) and the Nevada Division of Forestry (NDF). Before seeding, receive written approval from BLM and NDF for the method and rate of application for the seed mixture.

(d) Apply the requirements outlined above, pertaining to removing, stockpiling, and relaying the top 150 mm (6 in.) of material to areas first excavated on the project and not to areas previously excavated where all topsoil has been removed.

(e) Accomplish the work required herein before completion of the project and at no cost to the Department.

Make, at own expense, any and all arrangements necessary for hauling over local, public or private roads or property from any source.

Do not use or disturb existing aggregate stockpiles within U.S. Government or Department-furnished sources unless granted permission in writing.

Be solely responsible in determining the type and quantity of equipment in addition to estimating the necessary work required for producing a material meeting all specification requirements obtained from any material source.

Variation in both quantity and quality of material obtained from a material deposit is a normal occurrence and shall be expected. Be solely responsible in determining the use of any material site for production of project materials.

The Department will not pre-qualify nor quantify existing material within any deposit. If electing to use any material source, be solely responsible in determining if an adequate quantity of useable materials meeting specification requirements exists within the material deposit. During the bidding process, address any and all concerns associated with any material source's quality and/or quantity necessary to meet project needs.

Any data the Department may have on file regarding material sites is solely for informational purposes and is not a warranty of the quality or quantity of existing materials within any deposit. Be solely responsible for interpreting or evaluating any testing reports. Through supplying this data, the Department is not representing that a bidder should necessarily expect to produce any materials corresponding with those previously produced by others or expect to produce any specification products from the material source. Any data currently on file may be reviewed at the Department's Materials Division, 1263 S. Stewart Street, Carson City, Nevada 89712, phone (775) 888-7520. The data on file with the Department is not a part of the contract documents. The data may be incomplete and/or out of date. Be advised to check dates upon which any data was compiled and take into account the possibility that certain materials found in prior testing may have subsequently been removed from the site. Be advised that only

limited testing or evaluation of materials in any deposit may have been performed. Actual inspection and testing is necessary to determine quantities available and evaluate means and methods required to achieve project requirements. The foregoing is applicable to data on file for all sources, including sources designated as mandatory.

Understand, that during the life of this contract, other contractors working on other State projects, may be allowed the use of the material deposits. In the event other contractors use a deposit concurrently, coordinate operations with the other contractors in such a manner that all requirements, restrictions, and stipulations specified in the Standard Specifications and the Special Provisions are met.

**106.03 Possible Local Material Sources.** Contact the local Bureau of Land Management (BLM) Office at least one month before using any material source under the jurisdiction of the BLM. The contact is to allow BLM the option to salvage plants on undisturbed lands expected to be utilized. Coordinate use of the material source with any BLM plant salvage operations. To the maximum practicable extent, avoid existing pinion trees, juniper trees, joshua trees, and cactus on such material sites.

If desiring to use materials from sources other than those described in Subsection 106.02 of the Special Provisions, acquire at own expense, the necessary right to take material and obtain all other necessary permits and approvals and comply with all the requirements and stipulations in effect by other governing agencies having jurisdiction over the area, and pay all costs involved, including any which may result from an increase in length of haul. Bear all costs of exploring and developing such alternate sources. Do not use material from such sources until representative samples taken by the Engineer have been approved and written authority issued for the use thereof.

Should such alternate source be located on U.S. Government owned land, make application to the Bureau of Land Management or other responsible agency for the right to remove materials therefrom and submit the required request for exploration permit, mining plan and/or other documents required by the agency involved.

Proposed alternate material sources shall be noxious weed free.

If electing to use an alternate source as provided in these specifications, and such alternate source is located on privately owned lands, satisfy the requirements of subparagraphs (a) through (d) listed below. The Department will not provide source acceptance testing until the requirements of subparagraphs (a) and (b) have been met. Upon satisfactory completion of these items, written approval will be given and shall constitute approval of the site as an alternate source, provided all other applicable requirements of these specifications are complied with.

(a) Procure all necessary permits and clearances for the proposed site. These clearances shall include environmental and cultural resource clearances pursuant to the National Environmental Policy Act (NEPA) and the National and Historic Preservation Act (36 CFR 800). Insure that the clearances cover the entire site including any haul roads and/or other affected areas such as pipelines, storage areas, etc. Upon completion of the clearance reports, provide three copies of each report to the Engineer. The reports will be forwarded to the Department's Environmental Services Division (ESD) for review and submission to external regulatory agencies as appropriate. Once the clearances have been obtained, the ESD will notify the Engineer that the Contractor may proceed with the use of the proposed site. Do not begin operations until given notification in writing.

(b) Provide 3 certified copies of the written agreement entered into between Contractor and Landowner. Terms of agreement shall include landowners consent to the performance of the work and operation required in Subsection 106.02, subparagraphs (a) through (e) inclusive. Terms of agreement shall hold harmless the Department for all material source operations.

(c) Seed and fertilize the excavated area and haul roads upon completion of materials extraction.

(d) Provide written evidence at completion of project, that the landowner has accepted the post construction condition of the site and that all terms of the agreement have been met.

If electing to use an alternate source as provided in these specifications, and such source is located on land under the jurisdiction of the Bureau of Land Management see new Part 23 of Title 43 Code of Federal Regulations titled "Surface Exploration, Mining and Reclamation of Lands." This regulation pertains to all exploration, developing, and obtaining material from said alternate deposits located upon land under the jurisdiction of the Bureau of Land Management. A pertinent portion of this Part 23 is included below. In addition, satisfy the requirements of subparagraph (a) above.

**§23.8 Approval of mining plan.**

(a) 1. Before surface mining operations may commence under any permit or lease issued under the mineral leasing acts the operator must file a mining plan with the mining supervisor and obtain his approval of the plan. Paragraphs (b) through (g) of this Section confer authority upon mining supervisors with respect to mining plans pertaining to permits or leases issued under the mineral leasing acts. The mining supervisor shall consult with the district manager with respect to the surface protection and reclamation aspects before approving said plan.

2. Before surface mining operations may commence under any permit issued or contract made under the Materials Act, the operator must file a mining plan with the district manager and obtain his approval of the plan. Paragraphs (b) through (g) of this Section confer authority upon district managers with respect to mining plans pertaining to permits issued or contracts made under the Materials Act.

(b) Depending on the size and nature of the operation and the requirements established pursuant to § 23.5, the mining supervisor or the district manager may require that the mining plan submitted by the operator include any or all of the following:

1. A description of the location and area to be affected by the operations;

2. Two copies of a suitable map, or aerial photograph showing the topography, the area covered by the permit, lease, or contract, the name and location of major topographic and cultural features, and the drainage plan away from the area to be affected;

3. A statement of proposed methods of operating, including a description of proposed roads or vehicular trails; the size and location of structures and facilities to be built;

4. An estimate of the quantity of water to be used and pollutants that are expected to enter any receiving waters;

5. A design for the necessary impoundment, treatment or control of all runoff water and drainage from workings so as to reduce soil erosion and sedimentation and to prevent the pollution of receiving waters;

6. A description of measures to be taken to prevent or control fire, soil erosion, pollution of surface and ground water, damage to fish and wildlife, and hazards to public health and safety; and

7. A statement of the proposed manner and time of performance of work to reclaim areas disturbed by the holder's operation.

(c) In those instances in which the permit, lease, or contract requires the revegetation of an area of land to be affected the mining plan shall show:

1. Proposed methods of preparation and fertilizing the soil before replanting;

2. Types and mixtures of shrubs, trees, or tree seedlings, grasses or legumes to be planted; and

3. Types and methods of planting, including the amount of grasses or legumes per acre, or the number and spacing of trees, or tree seedlings, or combinations of grasses and trees.

(d) In those instances in which the permit, lease, or contract requires regrading and backfilling, the mining plan shall show the proposed methods and the timing of grading and backfilling of areas to be affected by the operation.

(e) The mining supervisor or the district manager shall review the mining plan submitted to him by the operator and shall promptly indicate to the operator any changes, additions, or amendments necessary to meet the requirements formulated pursuant to § 23.5, the provisions of the regulations in this part and the terms of the permit, lease, or contract. The operator shall comply with the provisions of an approved mining plan.

(f) A mining plan may be changed by mutual consent of the mining supervisor or the district manager and the operator at any time to adjust to changed conditions or to correct any oversight. To obtain approval of a change or supplemental plan the operator shall submit a written statement of the proposed changes or

supplement and the justification for the changes proposed. The mining supervisor or the district manager shall promptly notify the operator that he consents to the proposed changes or supplement or, in the event he does not consent, he shall specify the modifications thereto under which the proposed changes or supplement would be acceptable. After mutual acceptance of a change of a plan the operator shall not depart therefrom without further approval.

(g) If circumstances warrant, or if development of a mining plan for the entire operation is dependent upon unknown factors which cannot or will not be determined except during the progress of the operation, a partial plan may be approved and supplemented from time to time. The operator shall not, however, perform any operation except under an approved plan.

**§ 23.9 Performance bond.**

(a) 1. Upon approval of an exploration plan or mining plan, the operator shall be required to file a suitable performance bond of not less than $2,000 with satisfactory surety, payable to the Secretary of the Interior, and the bond shall be conditioned upon the faithful compliance with applicable regulations, the terms and conditions of the permit, lease, or contract, and the explorations or mining plan as approved, amended or supplemented. The bond shall be in an amount sufficient to satisfy the reclamation requirements of an approved exploration or mining plan, or an approved partial or supplemental plan. In determining the amount of the bond consideration shall be given to the character and nature of the reclamation requirements and the estimated costs of reclamation in the event that the operator forfeits his performance bond.

2. In lieu of a performance bond an operator may elect to deposit cash or negotiable bonds of the U.S. Government. The cash deposit or the market value of such securities shall be equal at least to the required sum of the bond.

(b) A bond may be a nationwide or statewide bond which the operator has filed with the Department under the provisions of the applicable leasing regulations in Subchapter C of Chapter II of this title, if the terms and conditions thereof are sufficient to comply with the regulations in this part.

(c) The district manager shall set the amount of a bond and take the necessary action for an increase or for a complete or partial release of a bond. He shall take action with respect to bonds for leases or permits only after consultation with the mining supervisor.

(d) Performance bonds will not be required of Federal, State, or other governmental agencies. Where the exploration or mining is actually performed for such Federal, State, or governmental agencies by a Contractor who would have to post a bond under the terms of paragraph (a) of this Section if the Contractor were the operator, such agencies shall require the Contractor to furnish a bond payable to the United States which meets the requirements of paragraph (a) of this Section. If, for some other purpose, the Contractor furnishes a performance bond, an amendment to that bond which meets the requirements of paragraph (a) of this Section will be acceptable in lieu of an additional or separate bond.

Actual conditions and/or additional requirements shall be established by the governing Bureau of Land Management office.

Comply with the Bureau of Land Management's requirements of the General Surface Protection Clause as set forth herein for all deposits located on land under the jurisdiction of the Bureau of Land Management.

**General Surface Protection Clause**

**Protection of surface natural resources, and improvements.** Take such reasonable steps as may be needed to prevent operations on the servient lands from unnecessarily: (1) causing or contributing to soil erosion or damaging crops, including forage, and timber growth thereon or on Federal or non-Federal lands in the vicinity; (2) polluting air and water; (3) damaging improvements owned by the United States or other parties; or (4) destroying, damaging or removing vertebrate fossils, historic or prehistoric ruins or artifacts; and before completion of the project or at any other time prior thereto when required and to the extent deemed necessary by the Bureau of Land Management to fill any pits, ditches and other excavations, remove or cover all debris, and so far as reasonably possible, restore the surface of the land and any access roads to their former conditions, including the removal of structures as and if required.

**Antiquities and objects of historic value.** When American antiquities or other objects of historic or scientific interest, including but not limited to historic or prehistoric ruins, vertebrate fossils or artifacts, are discovered in the performance of the work, the item(s) or condition(s) will be left intact and immediately brought to the attention of the district manager or his authorized representative.

Upon written confirmation from the Bureau of Land Management to utilize alternate source, written approval shall be given and shall constitute approval of the site as an alternate source, provided all other applicable requirements of these specifications are complied with.

Where the Department has made arrangements with owners of land in the vicinity of a project for obtaining material from an owner's property, such arrangements are made solely for the purpose of providing all bidders an equal opportunity to obtain material from such property. Upon written request, the documents evidencing such arrangements between property owners and the Department may be inspected. Any rights that have been obtained, under such arrangements may be exercised subject to and upon the conditions hereinafter set forth.

It is expressly understood and agreed that the Department assumes no responsibility to the bidder or Contractor whatsoever in respect to the Department's arrangements made with the property owner to obtain materials therefrom and the Contractor shall assume all risks in connection with the use of such property.

The inclusion of documents setting forth the arrangements made with some property owners for obtaining material from such owners properties as set forth in Subsection 106.02 shall not in any respect operate as a waiver of any of the provisions in this Subsection concerning said documents.

Make such independent investigation and examination as deemed necessary to be satisfied as to the rights, duties, and obligations acquired or undertaken under such an arrangement with the property owner.

Do not obtain material from such property unless first having either:

(a) Executed a document that will guarantee to hold such owner harmless from all claims for injury to persons or damage to property resulting from the Contractor's operations on the property owner's premises and also agree to conform to all other provisions set forth in the arrangement made between the Department and the property owner. Said document will be prepared by the Engineer for execution by the Contractor; or

(b) Entered into an agreement with the owner of the material source on any terms mutually agreeable to the owner and the Contractor, and furnished a release, in a satisfactory form, executed by the owner, relieving the Department of any and all obligations under the Department's arrangement with the owner. Requirements as set forth in this Subsection for alternate sources located on privately owned lands shall apply.

If electing to obtain material under (a), subject the use of such site to the terms, conditions and limitations of the arrangement made between the property owner and the Department and pay such charges as are provided for in the arrangement made by the Department with the property owner.

Before final acceptance of the contract, submit written evidence that the owner of the material source is satisfied that the Contractor has satisfactorily complied with the provisions of the arrangement between the Department and the owner.

If entering upon any of the areas withdrawn or otherwise obtained by the Department from the U.S. Government, determine the rights of others in the area. Do not encroach on easements of others without their written permission and assume the responsibility for any damages due to entering said area. In addition, be bound by the terms, conditions and reservations contained in the approved application for withdrawal.

Materials to be incorporated in the contract may come from (a) Department-furnished sources, or (b) Contractor-furnished sources.

(a) Department-furnished sources. The Department may acquire and make available the use of material pits, quarry sites, rip rap sources, stockpile sites, plant sites and haul roads.

(b) Contractor-furnished sources. If electing to use material from sources other than those listed as available, acquire the necessary rights to take materials from the sources and bear all costs related thereto. Pay all costs for options or guarantees for pits moved from or not used.

Do not use material from such sources until representative samples, taken by the Engineer, prove that the material meets all applicable specifications and design requirements, and the Department certifies in writing that the material meets all of the design criteria used for the approval of the source set up on the plans. The Department will assume the cost of processing samples to determine the suitability of Contractor-furnished material.

Where the Department has obtained the right to remove materials from lands owned or controlled by the U.S. Government, by withdrawal or otherwise, and these areas are designated and set forth in the Special Provisions, entry upon and removal of materials for use on this contract only is allowed, without further permission from the U.S. Government, except as follows:

Comply with all Federal, State, and local laws, ordinances, rules, regulations, zoning, etc., and obtain all licenses, permits and pay all costs in relation thereto. There will be no adjustment in contract unit prices bid, or any adjustment of the contract time allowed due to the use of designated deposits.

The Department may, grant written permission to enter on, and remove materials from, areas withdrawn or otherwise obtained by the Department, but not designated in the Special Provisions. Approval to use any nondesignated source shall be subject to the following conditions:

(a) No such request will be considered before award of the contract.

(b) No such request will be considered unless it is accompanied by a written proposal which must show a substantial benefit to the public. The Department reserves the right to reject any proposal.

(c) Approval or rejection of any proposal will not be considered sufficient cause for any claim or any adjustment of the contract time.

(d) If the proposal is accepted, the Department will execute a contract change order setting forth the terms and conditions regarding the use of said deposit(s). Once the contract change order has been fully executed, the successful bidder may proceed under the conditions contained therein. In the event approval to use nondesignated sources results in a net cost savings, the Contractor shall receive 50% and the Department 50%.

(e) It is mutually understood and agreed by both parties to the contract, that the Department cannot guarantee the use of nondesignated deposits.

If the Department has obtained data on nondesignated material sources, such data will be available for review at the Department's Headquarters Materials Division, 1263 S. Stewart Street, Carson City, Nevada 89712, phone (775) 888-7520. The data on file with the Department is not a part of the contract documents. The data may be incomplete and/or out of date. Be advised to check dates upon which any data was compiled and take into account the possibility that certain materials found in prior testing may have subsequently been removed from the site. Be advised that only limited testing or evaluation of materials in any deposit may have been performed. Actual inspection and testing is necessary to determine quantities available and evaluate means and methods required to achieve project requirements.

**106.04 Samples and Tests.** Except as provided in Subsection 106.05, all materials will be inspected, and/or tested for acceptance before incorporation in the work. Perform informational testing as herein described. Any work in which untested and unaccepted materials are used without approval or written permission may be performed at the risk of being considered as unacceptable and unauthorized and not to be paid.

Produce materials at the plant that conform in all respects to the requirements of the specifications; however, blending on the roadbed to correct for minor deficiencies in grading or excess plasticity will be allowed, except for shouldering material, under the following conditions:

(a) All blending material added on roadway and all work involved in processing such material will not be paid for.

(b) Continue processing the material until a homogeneous mixture is obtained. Obtain uniform gradation to the degree that sieve analysis tests show less than 10% difference, plus or minus, in the amount of material passing the 1.18 mm (No. 16) sieve, determined by comparing sieve analysis tests on two samples of processed and blended material. Samples for tests, taken for the above conditions, will be confined within a distance of 150 m (500 ft) of each other and also taken in the same continuous windrow.

Perform informational process control sampling and testing by a materials testing firm or own testing personnel, using the applicable Nevada Test Methods which appear under “Project Control Tests” in Sections; 704, 705, and 706. Perform informational testing at the project site or as approved.

Testing personnel are required to be qualified in the Nevada Alliance for Quality Transportation Construction (NAQTC) Aggregate Module or Western Alliance for Quality Transportation Construction (WAQTC) Aggregate Module and Embankment and Base Module.

Testing procedures will be monitored on a random basis. Perform a minimum of one informational process control test for every 1,000 metric ton (1,100 ton) of each size aggregate produced, with a minimum of one test for each size or type per day of production.

Obtain samples of the finished product of the plant before or as the material leaves the conveyor belt for the bin or stockpile. Construct the sampling device so that small representative samples may be taken frequently and these small samples combined to form the complete sample. Deliver the samples by mechanical means to a point on the ground or other satisfactory safe and accessible location.

Furnish test results from samples taken, on a daily basis. The results of such tests shall not be the basis for final acceptance of the material.

All costs incurred in conducting informational process control sampling and testing will not be measured or paid for directly.

If disputing the Department’s acceptance testing, and electing to have independent testing performed, coordinate such testing with the Engineer before having the testing take place. Give notification in advance of sampling and testing to allow an opportunity for the Engineer or his designated representative to be present during sampling and/or testing. Do not begin sampling until permitted in writing. Submit coordination information in writing and include, as a minimum, the following:

(a) Purpose of testing.

(b) Specific tests to be performed.

(c) Procedures proposed for sampling and testing.

(d) Schedule of proposed sampling and testing.

(e) Name(s) of Firm and/or personnel to perform the sampling and testing.

Tests performed by other than the Engineer’s representative may be considered for informational purposes by the Department, however, such testing will not be used for acceptance purposes unless agreed to in writing by the Department. All acceptance testing will be performed by the Engineer, his designated representative, or as required by the specifications and shall be binding on the Contractor.

Sampling for final acceptance of materials will be as hereinafter outlined:

(a) Types 1, 2, and 3, Class B aggregate base courses and “selected material base or surface” will be sampled from the processed windrow just prior to final laydown.

(b) Types 1, 2, and 3, Class A aggregate base courses will be sampled from the roadbed directly behind the laydown machine and before the first pass of the roller.

(c) Aggregate for cement or lime treated bases will be sampled as follows:

1. Where the material is being mixed at a stationary plant, samples will be taken from the conveyors just before delivery to the mixer and before adding lime and cement.

2. Where material is being mixed on the roadbed, samples will be taken after the material has been placed on the roadbed and processed and before adding cement or lime.

(d) Aggregates for premixed bituminous paving material will be sampled before adding the bituminous material.

Equip sampling points with a sampling device so constructed that representative samples will be delivered by mechanical means to a point which is accessible, safe, and satisfactory.

(e) Aggregate for all plantmix bituminous mixtures will be sampled as follows: Continuous-Mix or Drum-Mix plants will be sampled after proportioning and before entering the pugmill or drum. Batch type plants will be sampled from the hot bins. Samples, except in batch type plants, will be taken before the point where mineral filler is added. Equip sampling points with a sampling device so constructed that representative samples will be delivered by mechanical means to a point which is accessible, safe, and satisfactory.

For gradation acceptance, samples will be taken from behind the lay down machine according to Test Method No. Nev. T200, procedure No. 10, except for aggregates for bituminous open-graded which will be sampled from the lay down machine according to Test Method No. Nev. T200, procedure No. 9. Sieve analysis will be performed on aggregates obtained from Test Method No. Nev. T761 (Ignition Method). No adjustment will be made to the gradation results for the addition of the mineral filler.

Samples for Liquid Limit and Atterburg Limit testing will be taken from the stockpile during production.

(f) Aggregate for screenings will be sampled from the job-site stockpiles, loaded truck, or spreader hopper. Aggregates for shoulder material will be sampled from the plant belt or stockpile.

Aggregate for screenings to be stockpiled for future use by the Department will be tested and accepted at the product belt before stockpiling.

(g) Pretreated aggregates in stockpile for plantmix bituminous mixtures will be sampled as follows: Continuous-Mix or Drum-Mix plants will be sampled after proportioning and before entering the pugmill or drum. Batch type plants will be sampled from the hot bins. Equip sampling points with a sampling device so constructed that representative samples will be delivered by mechanical means to a point which is accessible, safe and satisfactory.

Samples for Liquid Limit and Atterburg Limit testing will be taken from the stockpile during production, prior to marination.

For gradation acceptance, samples will be taken from behind the lay down machine according to Test Method No. Nev. T200, procedure No. 10, except for aggregates for bituminous open-graded which will be sampled from the lay down machine according to Test Method No. Nev. T200, procedure No. 9. Sieve analysis will be performed on aggregates obtained from Test Method No. Nev. T761 (Ignition Method). No adjustment will be made to the gradation results for the addition of the mineral filler.

(h) Sampling of bituminous materials, intended for use in prime, tack or seal coats, and surface treatments, shall be performed after the bituminous material has arrived at the job destination and before, or at the time of unloading the materials. Take one sample of material from each truck transport or distributor. Bituminous material at plant sites shall be sampled before use.

Take samples of bituminous material intended for use in plantmix bituminous mixtures from the bituminous feed line at a suitable location between the storage tank and the plant bituminous metering device. Take one sample for every 23 metric tons (25 tons) of asphalt used or any part thereof, and not less than one per day. Personnel sampling bituminous material are required to be qualified in the WAQTC Asphalt Module or NAQTC Specialized Test AASHTO T40 (Sampling Bituminous Material).

Perform sampling according to Test Method No. Nev. T723. The Engineer reserves the right to reject samples not obtained in conformance with Test Method No. Nev. T723.

Take samples during the established job working hours, or other times approved by the Engineer. The samples will be submitted to the Department's laboratory for testing. In the event the test results fail to comply with requirements, and sufficient sample is available, the remaining portion of the sample will be tested to confirm the initial test results.

Understand and agree that samples obtained by Test Method No. Nev. T723 will be considered as truly representative of the material delivered for incorporation into the work.

Sample containers will be furnished. Immediately after filling the sample container, tightly seal it, properly mark for identification, and present to the Engineer.

(i) Sampling of plantmix bituminous mixtures for Stabilometer Value, Indirect Tensile Strength, and Percent Air Void testing will be done from behind the lay down machine according to Test Method No. Nev. T200, procedure No. 10.

(j) Samples for the aforementioned materials produced under conditions other than contemplated herein will be taken at a time and place deemed appropriate.

**106.05 Certificates of Compliance.** The use of certain materials or assemblies may be permitted before sampling and testing if accompanied by a Certificate of Compliance stating that the materials involved comply in all respects with the requirements of the specifications. Provide the certificates signed by the manufacturer of the material or the manufacturer of assembled materials. Furnish a Certificate of Compliance with each lot of material delivered to the worksite and clearly identify the lot so certified in the certificate.

The Certificate of Compliance will be used as a basis for permitting immediate use of the material on the job and shall represent conditional acceptance only. All materials used on the basis of a Certificate of Compliance may be sampled and tested at any time. Any such material not conforming to the requirements of the plans and specifications will be subject to rejection whether in place or not.

The Department reserves the right to refuse to permit the use of material on the basis of a Certificate of Compliance.

The form of the Certificate of Compliance and its disposition will be as directed. For metric unit contracts, report all test results in metric units or both metric and English units on the Certificates of Compliance. For English unit contracts, report all test results in English units or both English and metric units on the Certificates of Compliance.

All bituminous materials may be conditionally accepted at the worksite. Certificates of Compliance for asphalt cement, emulsified asphalt, and cutback asphalts shall certify that material conforms to the specifications, shall include test results for all tests specified, shipping point, and the date of test. All tests shall be performed by an AASHTO Materials Reference Laboratory accredited facility. A Certificate of Compliance shall accompany all samples of bituminous materials submitted for mix design or preliminary testing.

**106.06 Cited Specifications.** Unless otherwise specified, all tests will be performed according to the methods used by the Department.

The Department has developed test methods for testing the quality of materials and work. These test methods are identified by the prefix Nev. followed by the serial number. Copies of individual test methods are available at the Materials Division, Department of Transportation, Carson City, Nevada, and will be furnished to interested persons upon request.

Whenever a reference is made in the specifications to a test method by Nev. number, it shall mean the test method in effect on the date of the advertisement for bid.

Whenever a reference is made in the specifications to a test designation either of the ASTM, AASHTO, Federal specifications, or any other recognized national organization and the number or other identification accompanying the test designation representing the year of adoption or latest revision of the test is omitted, it shall mean the test method in effect on the date of advertisement for bid.

Whenever a reference is made in the specifications to a specification either of the ASTM, AASHTO, Federal specifications, or any other organization and the edition date is omitted, it shall mean the latest specification in effect on the date of advertisement for bid.

For metric unit contracts, the metric version of referenced specifications and tests shall apply if there is a choice between a metric or English unit version. For English unit contracts, the English version of referenced specifications and tests shall apply if there is a choice between an English or metric unit version.

When requested, furnish, without charge, samples of materials entering into the work. Do not use material before approval, except as provided in Subsection 106.05. Samples of material from local sources shall be taken by or in the presence of the Engineer; otherwise, the samples will not be considered for testing.

**106.07 Plant Inspection.** Certify concrete production facilities and delivery equipment by complying with National Ready-Mix Concrete Association certification requirements.

Plant produced precast concrete products proposed for use will require either National Precast Concrete Association (NPCA) or American Concrete Pipe Association (ACPA) certification. Manufacturers holding current Precast/Prestressed Concrete Institute (PCI) plant certification as specified in Section 503 are exempt from NPCA and ACPA plant certification requirements.

The Engineer may inspect the production of material or the manufacture of products at the source of supply. Plant inspection, however, will not be undertaken until assurance of the cooperation and assistance of both the Contractor and the material producer. Provide free entry at all times to such parts of the plant as concerns the manufacture or production of the materials. Furnish adequate facilities free of charge to make the necessary inspection.

The Department reserves the right to retest materials which have been tested and accepted at the source of supply before incorporation into the work after the same have been delivered, and to reject materials which, when retested, do not meet the requirements of the contract documents.

**106.08 Storage of Materials.** Store materials as to assure the preservation of their quality and fitness for the work. When required, store them in waterproof buildings, placed on wooden platforms or other hard, clean surfaces, and not on the ground, and cover. Stored materials, even though approved for use before storage, may be inspected before their use in the work, and they shall meet the requirements of the specifications at the time of this proposed use. Locate stored materials so as to facilitate their prompt inspection.

Aggregates which have been produced and stockpiled for use on State projects are subject to the following limitations:

(a) Stockpile separate and apart from materials that are not to be used on State contracts.

(b) Tag or mark in such a manner that they are easily identified as materials for State contracts.

(c) Allow access during normal working hours for periodic inspections by representatives of the State.

Upon approval, that portion of the cleared right of way not required for public travel, excluding existing avoidance areas, may be used for storage areas, staging areas, and equipment.

Make own arrangement for use of private or public property outside the highway right of way for storage, staging, or other project related areas and pay all costs involved.

Do not use private or public property for storage, staging, or other project related areas without written permission of the landowner and obtaining necessary permits and clearances as specified herein. Provide a certified copy of the agreement with the landowner along with a written release from the landowner absolving the State of any and all responsibility in connection with the use of the area. Do not begin operations in the area until after obtaining required permits and clearances, landowner approval, and written approval from the Engineer. Written agreements with the landowner shall not conflict with the environmental and cultural resource requirements, or any other Federal, State, and local laws, regulations, and ordinances.

Permits and clearances shall include environmental and cultural resource clearances pursuant to the National Environmental Policy Act (NEPA) and the National Historic Preservation Act (36 CFR 800). Insure that the clearances cover the entire site including any haul roads, access roads and/or other affected areas such as pipelines, etc. Upon completion of the clearance reports, provide three copies of each report to the Engineer. Their reports will be forwarded to the Department's Environmental Services Division (ESD) for review and submission to external regulatory agencies as appropriate. Once the clearances have been obtained, the ESD will notify the Engineer that the Contractor may proceed with the use of the proposed site. Do not begin operations until given notification in writing.

Restore all storage, staging, and project related areas to their original condition or as required under any permits or per the agreement with the property owner.

Provide written evidence, at completion of project, that the landowner has accepted the post construction condition of the site and that all the terms of the agreement have been met.

Consider full compensation for all costs involved in obtaining clearances, use and restoration of storage, staging, and project related areas located outside of the highway right of way as included in the price paid for the contract items of work.

**106.09 Handling Materials.** Handle materials in such manner as to preserve their quality and fitness for the work. Transport aggregates from the storage site to the work without loss or segregation of materials after loading and measuring in order that there may be no inconsistencies in the quantities of materials intended for incorporation in the work as loaded, and the quantities as actually received at the place of operation.

**106.10 Unacceptable Materials.** Materials not substantially conforming to the requirements of the specifications at the time they are used shall be considered as unacceptable and all such materials will be rejected and shall be removed immediately from the site of the work. Do not use rejected material, the defects of which have been corrected, until approval has been given.

**106.11 Department Furnished Material.** Furnish materials required to complete the work, except those specified to be furnished by the Department. Material furnished by the Department will be delivered or made available at the points specified in the Special Provisions.

Consider cost of handling and placing all materials after they are delivered or made available as included in the contract price for the item in connection with which they are used.

Be responsible for all material delivered, and deductions will be made from any money due to make good any shortages and deficiencies, from any cause whatsoever, and for any damage which may occur after such delivery and for any demurrage charges.

**106.12 Buy America.** In accordance with Title 23 CFR 635.410, permanently incorporated steel and/or iron materials on Federal-Aid projects shall be domestically produced regardless of the percentage they comprise in a manufactured product or form they take.

Minimal use of foreign steel materials will be permitted provided the cost of said materials does not exceed 1/10 of 1% of the total contract cost or $2,500.00, whichever is greater. The combined cost of foreign steel and/or iron materials will be the value of the materials as they are delivered to the contract, documented by invoice or bill of sale to the contractor. Submit for review a request to use foreign materials, prior to their use. Do not incorporate any foreign steel materials into the project without approval.

To qualify as domestic steel, all manufacturing processes, including manufacture, fabrication, grinding, drilling, welding, finishing, coating, and assembly of product containing steel and/or iron materials, must have been performed in the United States. To further define the coverage, a domestic product is a manufactured steel and/or iron materials construction material that was produced in one of the 50 states, the District of Columbia, Puerto Rico, or in the territories or possessions of the United States. Raw materials used in the steel and/or production may be imported. Raw materials are materials such as iron ore, limestone, waste products, etc. which are used in the manufacturing process to produce the steel and/or irons materials products. Waste products include scrap; i.e., steel no longer useful in its present form from old automobiles, machinery, pipe, railroad rail, steel trimmings from mills or product manufacturing, and the like. Extracting, crushing, and handling the raw materials which are customary to prepare them for transporting are exempt from Buy America. The use of foreign steel or iron billets is not acceptable under Buy America.

Provide a Certificate of Materials Origin, using NDOT form 020-095, certifying materials comply with the Buy America requirements as specified above. Submit the certification prior to installation of the material. Unless a Certificate of Materials Origin has been provided, the materials will be considered of foreign origin.

# SECTION 107

## LEGAL RELATIONS AND RESPONSIBILITY TO THE PUBLIC

**107.01 Laws to be Observed.** Keep fully informed of all Federal and State laws, all local bylaws, ordinances and regulations, and all orders and decrees of bodies or tribunals having jurisdiction or authority, which in any manner affect those engaged or employed on the work, or which in any way affect the conduct of the work. Observe and comply with all such laws, bylaws, ordinances, regulations, orders and decrees, and protect and indemnify the State and its representatives against any claim or liability arising from or based on the violation of any such law, bylaws, ordinances, regulations, orders or decrees, whether by yourself or your employees. If the Department suffers any fines or penalties because of the failure to comply with said laws or regulations, the Department may deduct the amount of said fine or penalty from any monies due.

Any project related use of areas outside of the highway right of way are subject to all applicable Federal, State, and local laws, regulations, ordinances and clearances (including but not limited to environmental and archaeological clearances), as well as the requirements and conditions as specified herein.

Use hauling vehicles transporting materials to and from the project either empty or loaded meeting the requirements and complying with laws and regulations as would be required when traveling on a public street or highway for any other purpose.

During the performance of all contracts, the contractor, for itself, its assignees and successors in interest (hereinafter referred to as the "Contractor") agrees as follows:

(1) Compliance with Regulations: The Contractor shall comply with the Regulation relative to nondiscrimination in federally-assisted programs of the Department of Transportation (hereinafter, "DOT") Title 49, Code of Federal Regulations, Part 21, and the Federal Highway Administration (hereinafter “FHWA”) Title 23, Code of Federal Regulations, Part 200 as they may be amended from time to time, (hereinafter referred to as the Regulations), which are herein incorporated by reference and made a part of this contract.

(2) Nondiscrimination: The Contractor, with regard to the work performed by it during the contract, shall not discriminate on the grounds of race, color, national origin, sex, age, disability/handicap, and low income status in the selection and retention of subcontractors, including procurements of materials and leases of equipment. The Contractor shall not participate either directly or indirectly in the discrimination prohibited by 49 CFR, section 21.5 of the Regulations, including employment practices when the contract covers a program set forth in Appendix B of the Regulations.

(3) Solicitations for Subcontractors, Including Procurements of Materials and Equipment: In all solicitations either by competitive bidding or negotiation made by the Contractor for work to be performed under a subcontract, including procurements of materials or leases of equipment, each potential subcontractor or supplier shall be notified by the Contractor of the Contractor's obligations under this contract and the Regulations relative to nondiscrimination on the grounds of race, color, national origin, sex, age, disability/handicap, and low income status.

(4) Information and Reports: The Contractor shall provide all information and reports required by the Regulations or directives issued pursuant thereto, and shall permit access to its books, records, accounts, other sources of information, and its facilities as may be determined by the Nevada Department of Transportation (hereinafter, “NDOT”) or the FHWA to be pertinent to ascertain compliance with such Regulations, orders and instructions. Where any information required of a Contractor is in the exclusive possession of another who fails or refuses to furnish this information the Contractor shall so certify to the NDOT, or the FHWA as appropriate, and shall set forth what efforts it has made to obtain the information.

(5) Sanctions for Noncompliance: In the event of the Contractor's noncompliance with the nondiscrimination provisions of this contract, the NDOT shall impose such contract sanctions as it or the FHWA may determine to be appropriate, including, but not limited to:

a. withholding of payments to the Contractor under the contract until the Contractor complies, and/or
b. cancellation, termination or suspension of the contract, in whole or in part.

(6) Incorporation of Provisions: The Contractor shall include the provisions of paragraphs (1) through (6) in every subcontract, including procurements of materials and leases of equipment, unless exempt by the Regulations, or directives issued pursuant thereto.

The Contractor shall take such action with respect to any subcontract or procurement as the NDOT or the FHWA may direct as a means of enforcing such provisions including sanctions for non-compliance: Provided, however, that, in the event a Contractor becomes involved in, or is threatened with, litigation with a subcontractor or supplier as a result of such direction, the Contractor may request the NDOT to enter into such litigation to protect the interests of the NDOT, and, in addition, the Contractor may request the United States to enter into such litigation to protect the interests of the United States.

**107.02 Permits, Licenses, and Taxes.** Procure all permits and licenses, pay all charges and fees, and give all notices necessary and incident to the due and lawful prosecution of the work, including vehicular registration or prorate registration and carrier licensing as applicable. Privilege taxes are in addition to the above fees. If having vehicles not licensed or registered in Nevada, contact the Motor Carrier Division of the Department of Motor Vehicles, Carson City, Nevada, for full information.

**107.03 Patented Devices, Materials, and Processes.** If employing any design, device, material, or process covered by letters of patent or copyright, provide for such use by suitable legal agreement with the patentee or owner. Indemnify and save harmless the State, any affected third party, or political subdivision from any and all claims for infringement by reason of the use of any such patented design, device, material, or process, or any trademark or copyright. Indemnify the State for any costs, expenses, and damages which it may be obliged to pay by reason of any such infringement at any time during the prosecution or after the completion of the work.

**107.04 Restoration of Surface Opened by Permit.** The right to construct or reconstruct any utility service in the highway or street, or to grant permits for same, at any time, is hereby expressly reserved by the Department for the proper authorities of the municipality or other political subdivision in which the work is done and the Contractor shall not be entitled to any damages either for the digging up of the street or for any delay occasioned thereby.

Any individual, firm, or corporation wishing to make an opening in the highway must secure a permit from the Department. Allow parties bearing such permits, and only those parties, to make openings in the highways. When ordered, make in an acceptable manner, all necessary repairs due to such openings, and such necessary work will be paid for as extra work, and will be subject to the same conditions as original work performed.

**107.05 Federal Aid Provisions**. (a) Work Subject to Inspection and Approval of Federal Agency. When the United States Government pays all or any portion of the cost of the work, observe the Federal laws authorizing such participation and the rules and regulations made pursuant to such laws. Subject the work to the inspection of the authorized representatives of such Federal agencies as are created for the administration of these laws, but such inspection will in no sense make the Federal Government a party to the contract and will in no way interfere with the right of either party hereunder.

(b) Fair Labor Standards Act. The Wage and Hour Division, U.S. Department of Labor requires that contractors or subcontractors engaged in highway construction work meet the provisions of the Fair Labor Standards Act of 1938 (52 Stat. 1060) or as amended. (Title 29, United States Code, Section 201, et seq.).

(c) Cargo Preference Act. Contractors or subcontractors engaged in transoceanic shipment of any equipment, material, or commodities pursuant to this contract, are required to meet the provisions of the Cargo Preference Act of 1954 (46 CFR 381, paragraph 7b) or as amended.

(d) Nondiscrimination Assurance. The Contractor or subcontractor shall not discriminate on the basis of race, color, national origin, or sex in the performance of this contract.

**107.06 Sanitary, Health, and Safety Provisions.** Provide and maintain in a neat, sanitary condition, such accommodations for the use of employees as may be necessary to comply with the requirements and regulations of the State Department of Health and of other bodies or tribunals having jurisdiction thereover. Commit no public nuisance.

See Federal, State, and local laws, rules, and regulations concerning construction safety and health standards. Do not require any workers to work in surroundings or under conditions which are unsanitary, hazardous, or dangerous to their health or safety.

Report all illicit discharges, in accordance with Section 6, NS-6 of the Department's Construction Best Management Practices (BMP) Manual, immediately upon discovery.

**107.07 Public Convenience and Safety.** Conduct the work in such a manner as will obstruct and inconvenience traffic as little as possible. Keep existing travel roads and streets adjacent to or within the limits of the improvement, open to and in a good, dust free and safe condition for traffic at all times. See Section 637. Maintain said roads and streets by removing any material or debris resulting from or caused by operations and repair any damage which may result from operations. Clean track out areas on all public roads at the end of each shift, a minimum of once daily if working multiple shifts, with a combination of water and a mechanical sweeper. For failure to clean track out areas, liquidated damages will be assessed according to Subsection 108.09 of the Special Provisions. For those roads and streets actually under physical improvement, see Section 624. Where grading operations are on or adjacent to the existing traveled way, finish the grade immediately after the rough grading is completed and place the surfacing material thereon as the work progresses. So conduct operations as to have under construction no greater length or amount of work than can be prosecuted vigorously and do not open up sections of the work and leave them unfinished, but finish the work as it goes insofar as practicable.

Perform work in a manner to assure full compliance with all applicable Federal, State, and local laws and regulations governing safety, health, and sanitation. Provide adequate safeguards, safety devices, and protective equipment such as are specified in other Sections of these specifications, or other documents and take any other ordered actions as determined reasonably necessary to protect the life and health of employees on the job and the safety of the public and to protect property in connection with the performance of the work covered by the contract.

At all times during the progress of the work or temporary suspension of the work, provide, erect, and maintain all necessary barricades, suitable and sufficient red lights, danger signals, temporary striping and signs, provide a sufficient number of flaggers and take all necessary precautions for the protection of the work and safety of the public, and those engaged on the work. Illuminate barricades and obstructions at night with reflectorized signs and lights, and keep lights for this purpose burning from sunset to sunrise. Barricades, warning signs, lights, temporary signals, and other protective devices shall conform with the MUTCD.

Retain a person certified by the American Traffic Safety Services Association (ATSSA) as a worksite traffic control supervisor as specified in Subsection 624.03.06. No direct payment will be made for providing a worksite traffic control supervisor unless a pay item for a Traffic Control Supervisor is provided in the proposal.

Where speed zones are established or where traffic is controlled either for safety of the traveling public or for protection of the work, do not exceed equipment speeds as ordered.

**107.08 Relations with Railroads.** (a) Definitions. The following definitions shall apply to the terms as herein used. *Railroad:* The railway or railroad company whose tracks are crossed or whose property is adjacent to the work or upon whose property the work is performed. *Chief Engineer:* The Chief Engineer of the Railroad or his authorized representatives. *Railroad Crossing:* A crossing at grade of the tracks of a Railroad and the highway. *Grade Separation:* A permanent structure to effect the separation of grades between the highway and the Railroad.

(b) Work or Operations. Subject work or operations on grade separations, Railroad crossings, or upon Railroad property to inspection by the Chief Engineer, and conduct and perform in a manner satisfactory to the Chief Engineer.

So arrange and conduct construction operations as to insure safe and uninterrupted operation of the Railroad traffic. Be responsible for any damages which result either directly or indirectly from the operations.

Notify the Chief Engineer in writing, at least 48 hours before starting any work in the proximity of the tracks, setting forth specifically the time at which it is planned to start such work.

Unless otherwise provided, do not pile or store any material, or park or use equipment closer than 7.6 m (25 ft) from the centerline of the tracks.

Keep the track zone clean of all loose material or debris at all times. Be responsible for any fouling of Railroad ballast resulting from sandblasting and painting operations and reimburse the Railroad for the replacement of all ballast so fouled.

In advance of any blasting, notify the Chief Engineer in order that proper flagging protection may be provided by the Railroad. Sheet excavations in the proximity of the tracks. Submit plans therefore to the Chief Engineer and receive approval before commencing any such excavation.

Make arrangements with the Railroad for crossing Railroad tracks at locations other than existing public crossings and bear all costs relative thereto.

Submit detail plans of falsework and forms for track spans and piers or abutments to the Chief Engineer. Do not commence work thereon until such plans have been approved by the Chief Engineer. Do not deviate from falsework plans thus approved without permission of the Chief Engineer. Maintain the temporary vertical and horizontal clearances specified by the Chief Engineer. In the case of impaired vertical clearances above the top of rail, the Railroad shall have the option to install telltales, or other such protective devices the Railroad deems necessary, for the protection of train persons or rail traffic.

Comply with the rules and regulations of the Railroad with respect to the work or operations on or adjacent to Railroad property. Arrange with the Railroad for the services of such qualified Railroad employees as the Chief Engineer may prescribe to protect and safeguard the Railroad's property, engines, trains and cars. Payment for such services, including compensation, insurance, vacation and holiday time, Railroad retirement and unemployment taxes, health and welfare, accounting and billing charges, will be paid by the Department directly to the Railroad, except all costs incurred by the Contractor which are applicable to any private crossing agreement(s) not provided in the contract. Any costs incurred relative to private crossing agreements for crossings not provided in the contract shall be paid by the Contractor directly to Railroad according to the Railroad's payment requirements.

Upon completion of the work upon Railroad's property, promptly remove all tools, equipment, and other materials, whether brought upon said property, and cause said property to be left in a clean and presentable condition.

(c) Work or Operations Performed by Railroad. The Railroad may undertake certain work or operations incidental to the project which are the subject of an agreement between the Department and the Railroad. Details of such work or operations will be set forth in the Special Provisions. Discuss such items with the Chief Engineer in order to develop a plan to accomplish the work or operations in their logical sequence and order.

Bear the cost of movement or adjustment of telephone, telegraph, or signal facilities owned, operated, or maintained by the Railroad and not otherwise provided for on the plans or in the Special Provisions.

(d) Insurance. Provide and maintain during the effective life of the contract such special or additional insurance as is required by Subsection 107.11. Furnish such evidence as may be required that such insurance has been provided.

(e) Qualification. Be responsible to satisfactorily perform work upon the Railroad's property.

(f) Reference. The provisions of Subsections 624.03.03, and 624.03.04, and 107.11 shall inure directly to the benefit of the Railroad.

**Union Pacific Railroad Company**

(a) General. The term "Railroad" shall be understood to mean the Union Pacific Railroad Company.

It is expected that the Railroad will cooperate to the end that the work may be handled in an efficient manner, but have no claim for damages or extra compensation in the event work is held up by the work of Railroad forces.

(b) Railroad Requirements. Cooperate with the Railroad where work is over or under the tracks, or within the limits of Railroad property, in order to expedite the work and to avoid interference with the operation of Railroad equipment.

Contact the Union Pacific Railroad Company representative listed in the Special Provisions to determine the requirements of the Railroad.

Comply with the rules and regulations of Railroad or the instructions of its representatives in relation to the proper manner of protecting the tracks and property of Railroad and the traffic moving on such tracks, as well as the wires, signals, and other property of Railroad, its tenants or licensees, at and in the vicinity of the work during the period of construction.

The Railroad requires safety training for all workers who will be working in the Railroad's right of way. The Railroad will provide safety training of 4 to 6 hours for the Contractor's supervisors at a site to be determined by the Railroad. The Contractor's supervisors will then be responsible for training the remaining work force with the curriculum information required by the Railroad. Upon request be prepared to provide records of the completed safety training for all such workers.

Telephone the Railroad's fiber optic company at 1-800-336-9193 (a 24 hour number) to determine if a telecommunications system is buried anywhere on or about the premises defined or included herein. If it is, Grantee will telephone the owner of the system designated by Railroad, arrange for a cable locator and make arrangements for relocation or other protection of the system prior to beginning any work on said premises.

Perform work in such manner and at such times as shall not endanger or interfere with the safe operation of the tracks and property of Railroad and the traffic moving on such tracks, as well as wires, signals and other property of Railroad, its tenants or licensees, at or in the vicinity of the work.

Except as otherwise provided herein, do not infringe operations on the following minimum clearances from any Railroad track:

7.6 m (25 ft) horizontally from center line of track

7.0 m (23 ft) vertically above top of rail

Submit any proposed infringement on the above clearances due to operations to the Railroad and to the Engineer, and do not undertake until approved by the Railroad, and until the Engineer has obtained any necessary authorization from any governmental body or bodies having jurisdiction thereover. No extra compensation will be allowed in the event work is delayed pending Railroad approval and governmental authorization.

In the case of impaired vertical clearance above top of rail, Railroad shall have the option of installing telltales or other protective devices Railroad deems necessary for protection of Railroad train person or rail traffic.

Furnish 6 sets of plans showing details of construction affecting the Railroad's tracks and property, including those for shoring and supports at excavations, not included in the contract plans, to the Engineer at least 90 days in advance of the time of beginning such work and do not begin such work until notified by the Engineer that such plans have been approved. The Engineer's approval of the plans does not relieve the Contractor from the responsibility for results obtained by use of said plans.

Give notification in writing, at least 25 days but not more than 40 days in advance of the starting date of installing temporary work with less than permanent clearance at each structure site. Do not proceed with work across Railroad tracks unless this requirement has been met. No extension of time or extra compensation will be allowed in the event work is delayed because of failure to comply with requirements in this paragraph.

Except in connection with construction of grade separation structures on premises of Railroad, no private crossings at grade over tracks of Railroad for the purpose of hauling earth, rock, paving or other materials will be permitted. If desiring, for the purpose of constructing highway-railway grade separation structures, including construction ramps thereto, to move equipment or materials across Railroad tracks, obtain permission from Railroad; and should it be required, execute a private crossing agreement. The crossing installation for the use of Contractor, together with any protective devices, if required, shall be at the expense of the Contractor. Furnish own employees as flagmen to control movements of vehicles on the private roadway and take all measures necessary to prevent the use of such roadway by unauthorized persons and vehicles.

In advance of any blasting, notify Railroad in order that proper flagging protection may be provided.

Upon completion of the work covered by this contract, upon the premises or over or beneath the tracks of Railroad, promptly remove from the premises of Railroad all tools, implements and other materials, whether brought upon said premises by you or any subcontractor, employee or agent of yourself or of any subcontractor, and cause said premises to be left in a clean and presentable condition.

(c) Protection of Railroad Facilities. Railroad representatives, conductors, flaggers or watch persons, will be provided by Railroad to protect its facilities, property and movements of its trains, or engines. In general, Railroad will furnish such personnel or other protective devices:

a. When any part of any equipment is standing or being operated within 4.5 m (15 ft), measured horizontally, from center line of any track on which trains may operate, or when any erection or construction activities are in progress within such limits, regardless of elevation above or below track.

b. For any excavation below elevation of track subgrade if, in the opinion of Railroad's representative, track or other Railroad facilities may be subject to settlement or movement.

c. During any clearing, grubbing, grading, or blasting in proximity to Railroad which, in the opinion of Railroad's representative, may endanger Railroad facilities or operations.

d. During any operations when, in the opinion of Railroad's representative, Railroad facilities, including, but not limited to, tracks, buildings, signals, wire lines or pipe lines, may be endangered.

(d) Work by Railroad Company. The Railroad will rearrange its telephone, telegraph and signal lines and appurtenances, and will make all track changes and will perform any other work in connection there with.

Any work by Railroad will be done by its own forces and is not a part of the work under this contract.

(e) Legal Relations. The provisions of this subsection, "Relations with Railroads," and the provisions of the following subsection, "Railroad Protective Insurance," shall inure directly to the benefit of the Railroad.

(f) Agreement. The Contractor is responsible for obtaining, completing and submitting the "APPLICATION FOR RIGHT OF ENTRY" which is available on the Internet at www.uprr.com. This application, along with an application fee and certificates of insurance, must be completed and submitted as soon as possible to the UPRR (Union Pacific Railroad Company) representative listed in the Special Provisions. Once received by UPRR it will be processed and a "CONTRACTORS RIGHT OF ENTRY AGREEMENT" will be prepared by UPRR and mailed back to the Contractor. The Contractor must sign this agreement and return it, along with a check (if required) to cover the Railroad's administrative fee, to UPRR for final execution. Only after the Contractor has received the fully executed "CONTRACTORS RIGHT OF ENTRY AGREEMENT" will he be allowed to begin work within the Railroad right-of-way. As this process can take up to 8 weeks, the Contractor must submit the application to UPRR as soon as possible.

**107.09 Liability Insurance.** (a) Insurance Requirements for Contractors. Do not commence any work or allow any subcontractor to commence any work under this contract until obtaining all insurance and bonds as required. Maintain for the duration of the contract, insurance against claims for injuries to persons or damages to property which may arise from or in connection with the performance of the work hereunder by the Contractor, his agents, representatives, employees, or subcontractors.

Consider full compensation for the cost of premiums on the insurance described herein as included in the prices paid for the various items of work to be performed under the contract, and no additional allowance will be made therefore or for additional premiums which may be required by extensions of the policies of insurance.

1. Minimum Scope of Insurance. Obtain and maintain in force for the full period of this contract:

a. Worker's Compensation Insurance.

b. Insurance Services Office Commercial General Liability Insurance Form or its equivalent.

c. Auto Liability Insurance, code 1, "any auto."

d. Excess Liability Insurance (Umbrella Form or Following Form Excess where necessary to meet the required minimum amounts of coverage).

e. Whenever construction operations covered under said contract are to be performed upon or in proximity to railroad property, provide public liability and property damage insurance for limits of coverage not less than required by the railroad.

2. Minimum Limits of Insurance. Maintain limits no less than:

a. Commercial General Liability. $1,000,000.00 per occurrence and $2,000,000.00 annual aggregate for bodily injury, property damage, including but not limited to personal injury, sickness, disease or death or damage to or destruction of the property of persons arising directly or indirectly out of or in connection with the performance of work under this contract.

b. Automobile Liability. $1,000,000.00 combined single limit per accident for bodily injury and property damage.

c. Worker's Compensation Insurance. Obtain worker's compensation insurance according to NRS Chapters 616 and 617 for employees engaged on or at the site of the project.

In the event any class of employee engaged in any work under this contract or at the site of the project is not protected under the State of Nevada Industrial Insurance Act, then provide and cause each subcontractor to provide adequate insurance coverage in a form and by an insurance carrier satisfactory to the State of Nevada for the protection of such employees. The insurance company shall agree to waive all rights of subrogation against the State of Nevada, its elected or appointed officers, officials, agents and employees for losses paid under the terms of this policy which arise from work performed by the named insured for the State of Nevada.

3. Deductibles and Self-Insured Retentions. Declare any deductibles or self-insured retentions to and receive approval by the State of Nevada. At the option of the State, either: the insurer shall reduce or eliminate such deductibles or self-insured retentions as respects the State of Nevada, Department of Transportation, its officers, officials and employees; or the Contractor shall procure a bond guaranteeing payment of losses and related investigation, claims administration and defense expenses.

4. Other Insurance Provisions. The policies are to contain or be endorsed to contain, the following provisions:

a. General Liability and Automobile Liability Coverages:

(1) The Nevada Department of Transportation, its officers, officials, employees, consultants, and volunteers are to be covered as additional insured's as respects: liability arising out of activities performed by or on behalf of the Contractor; products and completed operations of the Contractor; premises owned, leased or used by the Contractor; or automobiles owned, leased, hired or borrowed by the Contractor. The coverage shall contain no special limitations on the scope of protection afforded to the Nevada Department of Transportation, its officers, officials, employees, consultants, or volunteers.

(2) The Contractor's insurance coverage shall be primary insurance as respects the Agency, its officers, officials, employees and volunteers. Any insurance or self-insurance maintained by the Nevada Department of Transportation, its officers, officials, employees, or volunteers shall be excess of the Contractor's insurance and shall not contribute with it.

(3) Any failure to comply with reporting provisions of the policies shall not affect coverage provided to the Nevada Department of Transportation, its officers, officials, employees, or volunteers.

(4) The Contractor's insurance shall apply separately to each insured against whom claim is made or suit is brought, except with respect to the limits of the insurer's liability.

(5) The insurance companies shall immediately notify the Nevada Department of Transportation if, at any time during the term of the contract, the limits of the General Liability, or Excess Liability, including Aggregate Limits, as described on the certificates, have been impaired by more than 10% of the limits indicated for each policy.

(6) The insurance companies that provide Commercial General Liability coverage and/or Automobile Liability coverage shall waive their rights of subrogation against the additional insured.

b. All Coverages:

(1) Each insurance policy required by this clause shall be endorsed to state that coverage shall not be suspended, voided, canceled by either party, reduced in coverage or in limits except after 30 days prior notice given to the State of Nevada, Department of Transportation.

(2) Nothing contained in these insurance requirements is to be construed as limiting the extent of the Contractor's total responsibility for payment of claims arising in whole or in part from the actions of a third party when such actions might be taken as a result of the Contractor's operations under this contract.

(3) The Nevada Department of Transportation is not liable for the payment of any deductibles or assessments on any insurance policies purchased by the Contractor.

5. Acceptability of Insurers. Insurance is to be placed with insurers with a rating from the current issue of Best's Key Rating Guide of no less than A–:VII. The carrier shall have a home office in the United States. Lloyd's of London is the sole exception to the requirements of Best's Rating, financial size and home office location.

6. Instructions for Completions of Certificates of Insurance. At the time of executing this contract, deliver to the Nevada Department of Transportation, 1263 S. Stewart Street, Carson City, Nevada 89712, Attention: Labor Compliance Officer, a certificate of insurance evidencing coverage as specified.

a. If having Commercial General Liability Coverage as provided under the 1986 Occurrence Form, use Standard Accord Certificate 25-S (3/93 Rev.) If having Comprehensive General Liability Coverage as provided under the 1973 Occurrence Form, use Standard Accord Certificate 25-N (3/93). Claims made coverage is not acceptable.

b. By separate endorsements the State of Nevada, show the Department of Transportation to be an additional insured. Sign and attach the additional insured endorsement to the certificate. (It is understood that the certificates of worker's compensation insurance issued by Employers' Insurance Company of Nevada do not name additional insureds).

c. Sign and attach the waiver of subrogation endorsements to the certificate.

d. If the General Liability is provided on an aggregate limit per project, Form #CG2503(11/85) or CB2501(11/85), the Department shall waive the requirements that they be notified when limits have been impaired by more than 10% of the limits indicated. When the coverage is provided on an aggregate limit per project, attach a signed copy of the endorsement to the certificate.

e. Properly show the full legal operating names of the Contractor and insurance carrier on the certificate.

f. If the Contractor's Liability Coverage contains a deductible, show the amount of the deductible on the certificate. If there is no deductible, state it.

g. Amend the cancellation section of the certificate to amended to read as follows:

> "Should any of the above described policies be canceled or materially changed before the expiration date thereof the issuing company will mail 30 days written notice to the certificate holder named to the left."

h. All changes or alterations to the Certificate of Insurance as required by the State of Nevada shall be initialed by the authorized representative who signs the certificate.

i. The Certificate of Insurance must be countersigned by a resident agent in the State of Nevada according to NRS 680A.300.

j. The Certificate of Insurance must comply with all insurance requirements as set forth or the certificate will be rejected.

(b) Railroad Protective Insurance. In addition to any other form of insurance or bonds required under the terms of the contract and specifications, carry insurance of the kinds and in the amount hereinafter specified.

Such insurance shall be approved by the Railroad before any work is performed on or adjacent to Railroad property and shall be carried until all work required to be performed on or adjacent to the Railroad's property under the terms of the contract is satisfactorily completed as determined by the Engineer, and thereafter until all tools, equipment and materials have been removed from Railroad's property and such property is left in a clean and presentable condition.

Obtain the insurance herein required and furnish to the Engineer the original and certified copies of all policies as hereinafter specified.

Furnish the Engineer with one certified copy of each of the executed policies required below and, in addition, furnish the UPRR representative listed in the Special Provisions, one certified copy of each of the executed policies required below.

A certification on such copies of insurance shall guarantee that the policy required below will not be amended, altered, modified, or canceled insofar as the coverage contemplated hereunder is concerned, without at least 10 days notice mailed by registered mail to the Engineer and to the Railroad.

Full compensation for all premiums which the Contractor is required to pay on all the insurance described

hereinafter shall be considered as included in the prices paid for the various items of work to be performed under the contract, and no additional allowance will be made therefor or for additional premiums which may be required by extensions of the policies of insurance.

The approximate ratio of the estimated cost of the work over or under or within 15 m (50 ft) of Railroad's tracks to the total estimated contract cost will be shown in the Special Provisions.

During the life of the "CONTRACTORS RIGHT OF ENTRY AGREEMENT," procure and maintain the insurance coverages listed in the "UNION PACIFIC RAILROAD CONTRACT INSURANCE REQUIREMENTS" which is available on the Internet at www.uprr.com.

(c) General. Furnish the Department with one certified copy of all insurance required under subparagraph (a) of Subsection 107.09 and all copies and original(s) required under subparagraph (b) of Subsection 107.09. Send these copies and original(s) directly to the State of Nevada, Department of Transportation, 1263 South Stewart, Carson City, Nevada 89712—Attention: Contract Compliance Officer.

**107.10 Explosives.** When the use of explosives is necessary for the prosecution of the work, exercise the utmost care not to endanger life or property, including new work. Be responsible for all damage resulting from the use of explosives.

Store explosives in a secure manner in compliance with all laws and ordinances, and clearly mark all such storage places. Where no local laws or ordinances apply, provide satisfactory storage and in general not closer than 300 m (1,000 ft) from the road or from any building or camping area or place of human occupancy.

Notify each property owner and public utility company having structures or facilities in proximity to the site of the work of the intention to use explosives. Give such notice sufficiently in advance to enable the companies to take such steps as they may deem necessary to protect their property from injury.

**107.11 Responsibility for Damage Claims.** Indemnify, defend, and save harmless the Department, its officers and employees, and its consultants, from all suits, actions or claims of any character brought because of any injuries or damage received or sustained by any person, persons, or property on account of the operations of the said Contractor; or on account of or in consequence of any neglect in safeguarding the work; or through use of unacceptable materials in constructing the work; or because of any claims or amount recovered under the "Workman's Compensation Act," or any other law, ordinance, order or decree; and so much of the money due the said Contractor under and by virtue of his contract as may be considered necessary by the Department for such purpose, may be retained for the use of State; or in case no money is due, his surety may be held until such suit or suits, action or actions, claim or claims for the injuries or damages as aforesaid shall have been settled and suitable evidence to that effect furnished to the Department; except that money due the Contractor will not be withheld when the Contractor produces satisfactory evidence that he is adequately protected by public liability and property damage insurance.

Reimbursement by the State in whole or in part for costs of protecting traffic shall not serve to relieve the Contractor of his responsibility as set forth in these specifications.

Traffic control is the responsibility of the Contractor. Agree that neither the traffic control plan provided by the Department, nor the presence of Department personnel or consultants on the job site, nor instructions given by Department personnel or by consultants regarding traffic control will transfer responsibility for the traffic control to the Department or consultants. The purpose of Department inspectors or consultants is to ensure that the contract is performed according to its terms, and that the traffic control is maintained properly for the safety of workers and travelers. Department inspectors or consultants are not provided for the benefit of the Contractor.

Guarantee the payment of all just claims for materials, supplies and labor, and all other just claims against him or any subcontractor, in connection with this contract.

It is specifically agreed between the parties executing this contract that it is not intended by any of the provisions of any part of the contract to create the public or any member thereof a third party beneficiary hereunder, or to authorize anyone not a party to this contract to maintain a suit for personal injuries or property damage pursuant to the terms or provisions of this contract.

**107.12 Protection and Restoration of Property and Landscape.** Be responsible for the preservation from injury or damage resulting directly or indirectly from the work under this contract of all public and private property, crops, trees, vegetation, monuments, fences, highway signs, and markers, etc., along and adjacent to the highway.

Use every precaution necessary to prevent damage to pipes, conduits and other underground structures, to poles, wires, cables, and other overhead structures, whether shown on the plans or not. Carefully protect all land monuments and property marks from disturbance or damage until the Engineer has witnessed or otherwise referenced their location, and do not remove them until directed. Do not willfully or maliciously injure or destroy trees or shrubs and do not remove or cut them without proper authority.

Be responsible for all damage or injury to property of any character during the prosecution of the work resulting from any act, omission, neglect, or misconduct in the manner or method of executing said work, or at any time due to defective work or materials. Such responsibility shall not be released until the project has been completed and accepted.

Be responsible for the preservation of archeological and paleontological objects, including all ruins, sites, buildings, artifacts, fossils, or other objects of antiquity encountered during construction. When such objects are encountered, immediately cease operations and give notification that such objects exist. The Engineer will notify the Manager of the Cultural Resource Section of the Department. Reschedule construction operations to avoid the section until given written notification to proceed with operations.

Extension of contract time will be allowed for any delay due to preservation of archeological and paleontological objects.

When or where any direct or indirect damage or injury is done to public or private property by or on account of any act, omission, neglect or misconduct in the execution of the work or in consequence of the nonexecution thereof on part of the Contractor, restore at own expense such property to a condition similar or equal to that existing before such damage or injury was done by repairing, rebuilding, or otherwise restoring as may be directed, or make good such damage or injury in an acceptable manner. In case of failure to restore such property or make good such damage or injury the Engineer may, upon 48 hours written notice, proceed to repair, rebuild or otherwise restore such property as may be deemed necessary and the cost thereof will be deducted from any money due, or which may become due.

Restrict the movement of vehicles and other construction equipment and personnel to the construction area and designated roads. Take every precaution to prevent the marking of the natural ground with equipment tracks or other means outside of the slope stake areas on either side of the roadway and in median areas where it is not required to disturb the existing ground. Satisfactorily eradicate such markings of the natural ground caused by equipment, personnel, or operations, at own expense.

Locate roads in ditch and dike areas and do not allow equipment to travel outside the area to be occupied by said ditch or dike, except as provided for in Subsection 203.03.10. Cross median areas at structures or approved areas.

Where there is a high potential for erosion and subsequent water pollution, hold the area of erosive land that may be exposed by construction operations at any one time to a minimum, and keep the duration of the exposure of the uncompleted construction to the elements as short as practicable. Construct erosion control features concurrently with other work and at the earliest practicable time. See Section 211 and 637.

Do not disturb the lands and waters that are outside the limits of the construction as staked, except as may be found necessary and approved.

**107.13 Forest Protection.** Do not burn as a method of disposal. Abide by such rules and instructions as to fire prevention and control as the authorized representative of the appropriate agency having jurisdiction may prescribe. Take all necessary steps to prevent employees from setting fires during construction of the project and, under the direction of the appropriate Federal, State, or other agency, or, in the absence of an officer from any such agency, acting independently, extinguish all fires set or caused by employees and all other fires which may escape on the project, whether or not set directly or indirectly as a result of construction operations, without expense to the State or Federal government. Where obligated to suppress any fire, without expense to the State or Federal government, and if the amount of labor, subsistence, supplies and transportation which is furnished is inadequate in the opinion of the jurisdictional agency, then such agency may procure additional help or facilities and charge the expenses to the Contractor. These expenses shall be billed to the Contractor for payment directly by him, and if not promptly met by him will be deducted from the money due or which may become due under this contract.

Maintain a fire patrol in the vicinity of blasting and other operations creating a fire hazard. When, in the opinion of the agency having jurisdiction, such a patrol is unnecessary because of weather conditions, notification will be given.

Correct any unsafe condition as directed.

**107.14 Disposal of Material Outside Highway Right of Way.** Make own arrangements for disposal of materials outside the highway right of way and pay all costs involved.

When any non-hazardous earth material, composed of rock and soil, is to be disposed of outside the highway right of way, first obtain a written permit from the property owner on whose property the disposal is to be made and submit said permit or the certified copy thereof together with a written release from the property owner absolving the State of any and all responsibility in connection with the disposal of non-hazardous earth material on said property. Before any non-hazardous earth material is disposed of on said property, obtain written permission from the Engineer to dispose of the non-hazardous earth material at the location designated in the said permit.

Such disposal sites will not be approved when located within 300 m (1,000 ft) of a State highway right of way if the material placed thereon can be seen from said highway.

When any other non-hazardous material, including asphaltic material, concrete, steel, and wood is to be disposed of outside the highway right of way, dispose of it at an authorized Class I or II municipal landfill or at a permitted Class III industrial landfill permitted to accept only industrial solid waste.

It is encouraged that surplus non-hazardous material, including asphaltic material, concrete, steel, and wood be salvaged for recycling or converting to a new use, such as asphaltic grindings utilized as shouldering or base material, timbers for landscaping, or steel to a salvage yard, rather than disposing of the material. Do not place asphaltic material within 15 m (50 ft) of any live stream or other body of water. If any such non-hazardous material is to be salvaged outside the highway right of way, first obtain a written permit from the property owner on whose property the salvage is to be made and file with the Engineer said permit or the certified copy thereof together with a written release from the property owner absolving the State of any and all responsibility and liability in connection with the salvage of non-hazardous material on said property. Before any non-hazardous material is salvaged on said property, obtain written permission from the Engineer to salvage the non-hazardous material at the location designated in the said permit.

In addition to all other provisions of this agreement, handle, transport, and dispose of any waste materials generated from this project which are wastes subject to regulation as hazardous wastes as defined in the Nevada Administrative Code (NAC) 444.8565 according to the applicable Federal, State, and local regulations governing such handling, transport, and disposal.

Exercise precautions to prevent the discharge of hazardous wastes into the work area, any waterway, or the general environment. Contact the Nevada Department of Conservation and Natural Resources, Division of Environmental Protection, (775) 687-5872, for specific information and assistance.

The following shall apply to all Contractor obtained disposal sites located outside the right of way except public or commercial dumping grounds which have been approved for general use by appropriate governmental authorities:

(a) Before approval of such disposal sites, procure all necessary permits and clearances for the proposed site. These clearances shall include environmental and cultural resource clearances pursuant to the National Environmental Policy Act (NEPA) and the National and Historic Preservation Act (36 CFR 800). Insure that the clearances cover the entire site including any haul roads and/or other affected areas such as pipelines, storage areas, etc. Upon completion of the clearance reports, provide three copies of each report. The reports will be forwarded to the Department's Environmental Services Division (ESD) for review and submission to external regulatory agencies as appropriate. Once the clearances have been obtained, the ESD will notify the Engineer that the Contractor may proceed with the use of the proposed site. Do not begin operations until given notification in writing.

(b) Uniformly grade the site to drain and to blend with surrounding terrain.

(c) Finish slopes created by disposing of waste to a ratio of not less than 1:3 (3:1).

(d) Provide written evidence at completion of project, that the landowner has accepted the post construction condition of the site and that all the terms of the agreement have been met.

Consider full compensation for all costs involved in disposing of material as specified in this Subsection, including all costs of hauling, as included in the price paid for the contract items of work involving such materials.

**107.15 Relief from Maintenance and Responsibility.** Upon the written request, or upon order, the duty of maintaining and protecting certain portions of the work as described below, which have been satisfactorily completed in all respects according to the requirements of the contract may be relieved, and will not be required to do further work thereon. Such action will relieve the responsibility for injury or damage to said completed portions of the work resulting from use by the public traffic or from the action of the elements or from any other cause, but not from injury or damage resulting from operations or from own negligence.

Portions of the work for which the duty of maintenance and protection may be relieved as provided in the above paragraph include but are not limited to the following:

(a) The completion of 400 m (1,320 ft) of roadway or 400 m (1,320 ft) of one roadway of a divided highway or a frontage road including the traveled way, shoulders, drainage control facilities, planned roadway protection work, lighting, and any required traffic control and access facilities.

(b) A bridge or other structure of major importance.

(c) A complete unit of a traffic control signal system or of a highway lighting system.

(d) A complete unit of highway protection work.

(e) Any required traffic control and access facilities if the roadway or structure is to be used by public traffic before completion of the contract.

(f) Nonhighway facilities constructed for other agencies.

However, do not consider anything in this Subsection as relieving full responsibility for making good any defective work or materials found at any time before the formal written acceptance of the entire contract.

**107.16 Contractor's Responsibility for the Work and Materials.** Until the acceptance of the contract, maintain the charge and care of the work and of the materials to be used therein (including materials for which partial payment has been received as provided in Subsection 109.06) and bear the risk of injury, loss, or damage to any part thereof by the action of the elements or from any other cause, whether arising from the execution or from the non-execution of the work, except as provided in Subsection 107.15. Rebuild, repair, restore, and make good all injuries, losses, or damages to any portion of the work or the materials occasioned by any cause before its completion and acceptance and bear the expense thereof, except as otherwise expressly provided in Subsection 203.03.09, and Subsection 619.03.01, for object markers and guide posts, and except for such injuries, losses, or damages as are directly and approximately caused by acts of the Federal Government or the public enemy. Where necessary to protect the work or materials from damage, at own expense, provide suitable drainage of the roadway and erect such temporary structures as are necessary to protect the work or materials from damage. The suspension of the work from any cause whatever shall not relieve responsibility for the work and materials as herein specified. If ordered, at own expense, properly store materials which have been partially paid for by the State or which have been furnished by the State. Provide such storage on behalf of the State and the State shall at all times be entitled to the possession of such materials, and promptly return the same to the site of the work when requested. Do not dispose of any of the materials so stored except on written authorization.

**107.17 Contractor's Responsibility for Utility Property and Service.** Where operations are adjacent to properties of Railroad, utility or television cable companies, or are adjacent to other property, damage to which might result in considerable expense, loss, or inconvenience, do not commence work until all arrangements necessary for the protection thereof have been made.

Do not begin any operations which may interfere with or impair the normal service being rendered by public or private utility operators, until such operators have been notified. Cooperate with the owners of any underground or overhead utility lines in their removal and rearrangement operations in order that these operations may progress in a reasonable manner, and that duplication of rearrangement work may be reduced to a minimum, and that services rendered by those parties will not be unnecessarily interrupted. Be responsible for the protection of the property of public or private utilities within the limits of the work.

In general, repair and adjustment of street structures such as pipe lines, services, telephone, and electric lines, above or below the ground, will be made by the owners thereof. When included in the proposal, the adjustment of sewer manhole frames and covers, inlets and catch basin frames and covers and the like, will be within the Contractor's responsibility. See that they are adjusted to conform to the lines, grades, and typical cross sections as shown on the plans, or as prescribed, even if the repairs and the roughing-in work were performed by others.

Maintain pipes or other construction in continuous service as far as practicable and properly protect and support. Do not interrupt water service outside of working hours.

At all times allow the fire department access to fire hydrants. Do not place materials or other obstructions closer to a fire hydrant than permitted by ordinances, rules, or regulations or within 4.5 m (15 ft) of the fire hydrant in the absence of such ordinances, rules, or regulations.

Give notice in writing to the proper authorities in charge of streets, gas, water pipes, electric and other conduits, Railroads, poles, manholes, catch basins, and all other property that may be affected by the operations, not less than 2 working days, but not more than 14 days before breaking ground.

In the event of interruption to water or utility services as a result of accidental breakage, promptly notify the proper authority. Cooperate with said authority in the restoration of service as promptly as possible.

Utility installations shown on the plans are located according to best information obtained by the Department; however, consider it normal and expected that elevations and alignment of said utilities may vary from that shown on the plans, and also that utilities may be encountered that are not shown on the plans. The Contractor is solely responsible for ascertaining the actual location of all utility installations prior to beginning any excavation or other construction activity which may affect any utility installation. Consider it normal and expected that utilities will prove to be an impediment to the operations and that use of other than the usual equipment and construction methods in accomplishing the necessary work over, around, or under such utility installations may be necessary.

Locate and properly protect all utility installations. Repair all utility installations that are damaged by, or due to, operations or negligence.

See Subsection 105.07.

Contact “UNDERGROUND SERVICE ALERT” not less than 2 working days, but not more than 14 days, before starting any excavation. Contact by telephone and comply with all instructions so received. The toll free number is 1-800-227-2600.

If an underground facility must be located or adjusted for construction operations and its location is different from that shown on the plans, additional compensation may be received. This compensation will be for the difference between the costs incurred in finding the actual location of the facility and the costs of finding the reputed location of the facility and will be paid for as extra work.

**107.18 Furnishing Right of Way.** The Department will be responsible for the securing of all rights of way shown in the plans.

**107.19 Personal Liability of Public Officials.** In carrying out any of the provisions of these specifications or in exercising any power or authority granted to them by or within the scope of the contract, there shall be no liability upon the Directors, Engineer, or their authorized representatives, either personally or as officials of the State, with it being understood that in all such matters they act solely as agents and representatives of the State.

**107.20 No Waiver of Legal Rights.** The Department shall not be precluded or estopped by any measurements, estimate or certificate made either before or after the completion and acceptance of the work and payment therefore, from showing the true amount and character of the work performed, and materials furnished, nor from showing that any such measurements, estimate or certificate is untrue or is incorrectly made, nor that the work or materials do not in fact conform to the contract. The Department shall not be precluded or estopped, notwithstanding any such measurement, estimate, or certificate and payment in accordance therewith, from recovering from the Contractor or his sureties or both, such damages as it may sustain by reason of his failure to comply with the terms of the contract. Neither the acceptance by the Department, or any representative of the Department, nor any payment for or acceptance of the whole or any part of the work, nor any extension of time, nor any possession taken by the Department, shall operate as a waiver of any portion of the contract or of any power herein reserved, or of any right to damages. A waiver of any breach of the contract shall not be held to be a waiver of any other or subsequent breach.

**107.21 Water Supply.** (a) General. Provide an adequate water supply. Negotiate with owners of supply and sign an agreement with each owner before removing the water. Furnish a copy of said agreement. Pay all royalties occurring under such agreements and also obtain any necessary right of way.

(b) Water Wells and Well Points for Dewatering. Be aware that water usage may be limited in the project area. Monitoring the usage and effects on adjacent wells may also be required by the Department of Conservation and Natural Resources, Division of Water Resources. Contact the Office of the State Engineer for possible restrictions at (702) 486-2770 in Southern Nevada and (775) 684-2800 in Northern Nevada.

If electing to obtain water from an existing well or to drill a well for highway construction purposes, request a waiver be issued in accordance with Nevada Revised Statutes and the Nevada Administrative Code.

File all requests for waiver to the Engineer on the form from the Division of Water Resources website (http://water.nv.gov/). Ensure the request package includes the following information:

1. The location of the proposed water well by public survey, county assessor's parcel number and plot map.

2. The project and contract number.

3. The total amount of water that will be consumed each day.

4. The name, address, and telephone number of the person responsible for plugging the well. Also include the name, address, and telephone number of the owner of the land where the well is located if not the same as the person responsible for plugging the well.

5. A notarized affidavit signed by the person responsible for plugging the well which states that they will be responsible for plugging the well if it is abandoned.

6. The name, address, and telephone number of a person who will be available to answer questions concerning the contract.

7. The date the contract is scheduled to be completed.

Maintain a copy of the approved waiver onsite at all times during drilling operations.

Should circumstances dictate that the well location be moved outside of the 16.187 hectare (40 acre) subdivision described on the approved waiver, request an amendment using the correct Division of Water Resources form.

By signing and submitting a request for a waiver, agree to the following:

1. Comply with the requirements of the waiver.

2. Use a water well driller licensed in Nevada to perform all drilling and plugging. All drilling and plugging shall be in accordance with the "Regulations For Drilling Water Wells," current edition, which may be obtained from the Office of the State Engineer, Division of Water Resources, 901 S. Stewart Street, Suite 2002, Carson City, Nevada 89701-5250, phone (775) 684-2800.

3. Use the new well for highway construction purposes only, no other use will be considered or allowed.

4. Within 3 days of completion of the contract, defined as District acceptance, plug the well in accordance with the requirements of the Office of the State Engineer.

5. Notify the Office of the State Engineer of plugging within 30 days of contract completion. Provide a copy of said notification.

(c) Changes in the Diversion or Use of Surface Water. If electing to obtain water by a change in the place of diversion, manner of use or place of use of water already appropriated, apply for a permit in accordance with NRS 533.345.

The application for the permit to change the place of diversion, manner of use or place of use of water, already appropriated, may be obtained from and shall be filed with the Department of Conservation and Natural Resources, Office of the State Engineer, Division of Water Resources, 901 S. Stewart Street, Suite 2002, Carson City, Nevada 89701-5250, phone (775) 684-2800.

Provide a copy of the approved application.

# SECTION 108

## PROSECUTION AND PROGRESS

**108.01 Subletting of Contract.** Do not sublet, sell, transfer, assign, or otherwise dispose of the contract or contracts or any portion thereof or right, title or interest therein, without prior written consent of the Engineer and of the surety. The subcontractor or assignee shall not have any claim against the Department by reason of the approval of the subcontract or assignment.

Submit requests for permission to sublet, assign, or otherwise dispose of any portion of the contract in writing and accompany with a letter showing that the organization which will perform the work is particularly experienced for such work.

Consent to sublet, assign, or otherwise dispose of any portion of the contract shall not be construed to relieve the Contractor of his liability under the contract and bonds. Without exception and before the performance of any work by a subcontractor, submit a request to sublet and 2 certified copies of a fully executed subcontract between the Contractor and the subcontractor. This also applies to lower tier subcontracts.

In preparing such copies, the prices agreed upon for the work may be omitted, except as follows:

(a) The type, amount, and price for partial items of work must be clearly indicated.

(b) Subcontracts with DBE/SBE firms must clearly show the type, amount, and agreed price for the work.

The subcontractors shall not begin work on the contract until after these documents have been reviewed and approved.

All subcontractors and assignees of the prime or general Contractor shall be required to comply with the provisions of NRS 408.373 in the same manner as the prime or general Contractor.

See the paragraph contained in Subsection 110.01 pertaining to Title 29, Code of Federal Regulations, Part 1926.

See Subsection 102.03 for subcontractor information required on the day of bid opening.

According to NRS 338.141, do not substitute any person for a subcontractor who is named in the bid, unless:

(a) The Department objects to the subcontractor, requests in writing a change in the subcontractor and pays any increase in costs resulting from the change; or

(b) The substitution is approved by the Department and:

1. The named subcontractor, after having a reasonable opportunity, fails or refuses to execute a written contract with the Contractor which was offered to the subcontractor with the same terms that all other subcontractors on the project were offered;

2. The named subcontractor files for bankruptcy or becomes insolvent; or

3. The named subcontractor fails or refuses to perform his subcontract within a reasonable time.

Contract bid prices will prevail for purposes of computing the monetary value of all subcontracts.

Perform with own organization, work amounting to not less than 50% of the combined value of all items of the work covered by the contract except as follows:

(a) If electing to furnish materials for work to be performed by an approved subcontractor and the materials are not obtained from the same firm that is to perform the work of incorporating said materials into the project, the cost of said materials, when set forth in a written statement accompanying the subcontract agreement or contained therein, will be excluded from amounts applicable to the subcontracted percentage.
When a firm both sells materials to a Contractor and performs the work of incorporating the materials into the project, these 2 phases of work must necessarily be considered in combination and, as in effect, constituting a single subcontract.

(b) When performed by subcontract, any items that have been selected as “Specialty Items” for the contract will be excluded from amounts applicable to the subcontracted percentage. “Specialty Items” for the contract will be listed as such in the Special Provisions.

The contract amount bid for “Specialty Items” so performed by subcontract will be deducted from the original total contract price before computing the amount of work required to be performed by the Contractor with his own organization.

Roadside production of materials is construed to be the production of crushed stone, gravel, or other material with portable or semi-portable crushing, screening, or washing plants, established or reopened in the vicinity of the work for the purpose of supplying materials to be incorporated into the work. Roadside production of materials will be considered subcontracting if performed by other than the Contractor.

The Department and the Contractor will not recognize any subcontractor on the work as a party to the contract. Nothing contained in any subcontract shall create any contractual relation between the subcontractor and the Department. The Contractor will be held solely responsible for the progress of the work according to the progress required.

Insert in each subcontract all of the following contract provisions, copies of which are contained in the contract documents:

(a) LABOR PROVISIONS: The “DESIGNATED HOURLY MINIMUM WAGE RATES” supplied by the United States Department of Labor and the Labor Commissioner of the State of Nevada.

(b) FORM FHWA-1273: The “REQUIRED CONTRACT PROVISIONS FEDERAL-AID CONSTRUCTION CONTRACTS (Exclusive of Appalachian Contracts)” AND “APPENDIX A.”

(c) The “ADDITIONAL CONTRACT PROVISIONS—SUPPLEMENT TO THE WEEKLY CERTIFIED PAYROLLS.”

(d) The “STANDARD FEDERAL EQUAL EMPLOYMENT OPPORTUNITY CONSTRUCTION CONTRACT SPECIFICATIONS (EXECUTIVE ORDER 11246).”

(e) The “ADDITIONAL CONTRACT PROVISIONS—SPECIFIC EQUAL EMPLOYMENT OPPORTUNITY RESPONSIBILITIES.”

(f) The “ADDITIONAL CONTRACT PROVISIONS—EQUAL EMPLOYMENT OPPORTUNITY Training Special Provisions.”

(g) The certification on “RESTRICTIONS ON LOBBYING USING APPROPRIATED FEDERAL FUNDS.”

Insert the following statements in each subcontract:

“NON-DISCRIMINATION IN EMPLOYMENT
AND CONTRACT LABOR PROVISIONS”

“In connection with the performance of work under this contract, the CONTRACTOR agrees not to discriminate against any employee or applicant for employment because of race, creed, color or National origin; and further agrees to insert the foregoing provisions in all subcontracts hereunder.”

“Also included, and made a part of this subcontract agreement are the necessary Labor Provisions, including the “Designated Wages” as determined from wages supplied by the United States Department of Labor and the Labor Commissioner of the State of Nevada; Form FHWA-1273, the “Required Contract Provisions, All Federal-aid Construction Contracts (Exclusive of Certification Acceptance and Appalachian Contracts)”; the “Contract Work Hours Standards Act—Overtime Compensation.”

“Compliance with the Provisions of NRS 338.125 is mandatory insofar as it does not conflict with the above provisions of Title VI of the Civil Rights Act of 1964,” a pertinent portion is as follows:

“In connection with the performance of work under this contract, the contractor agrees not to discriminate against any employee or applicant for employment because of race, creed, age, color, national origin or sex. Such agreement shall include, but not be limited to, the following: Employment, upgrading, demotion or

transfer, recruitment or recruitment advertising, layoff or termination, rates of pay or other forms of compensation, and selection for training, including apprenticeship."

"NOTICE TO PROSPECTIVE SUBCONTRACTORS AND
MATERIAL SUPPLIERS OF REQUIREMENT FOR
CERTIFICATION OF NONSEGREGATED FACILITIES"

"A Certification of Nonsegregated Facilities as required by the May 9, 1967, Order of the Secretary of Labor (32 F.R. 7439, May 19, 1967) on Elimination of Segregated Facilities, must be executed by each subcontractor and material supplier prior to the award of the subcontract or consummation of a material supply agreement if such subcontract or agreement exceeds $10,000 and is not exempt from the provisions of the Equal Opportunity Clause."

"Subcontractors and material suppliers are cautioned as follows: By signing the subcontract or entering into a material supply agreement, the subcontractor or material supplier will be deemed to have signed and agreed to the provisions of the "Certification of Nonsegregated Facilities" in the subcontract or material supply agreement. This certification provides that the subcontractor or material supplier does not maintain or provide for his employees facilities which are segregated on the basis of race, creed, color, or national origin, whether such facilities are segregated by directive or on a de facto basis. The certification also provides that the subcontractor or material supplier will not maintain such segregated facilities."

"Subcontractors or material suppliers receiving subcontract awards or material supply agreements exceeding $10,000 which are not exempt from the provisions of the Equal Opportunity clause will be required to provide for the forwarding of this notice to prospective subcontractors for construction contracts and material suppliers where the subcontracts or material supply agreements exceed $10,000 and are not exempt from the provisions of the Equal Opportunity clause."

Also insert in each subcontract agreement, a clause requiring subcontractors to include the contract provisions mentioned herein in any lower tier subcontracts which they may enter into, together with a clause requiring the inclusion of these provisions in any further subcontracts that may in turn be made. The contract provisions shall in no instance be incorporated by reference.

The Contractor shall not terminate a DBE/SBE subcontractor (or an approved substitute DBE/SBE firm) listed as specified in Subsection 102.03 without written approval. This includes, but is not limited to, instances in which the Contractor seeks to perform work originally designated for a DBE/SBE subcontractor with its own forces or those of an affiliate, a non-DBE/non-SBE firm, or with another DBE/SBE firm.

The Department will provide such written approval only if it agrees that the Contractor has good cause to terminate the DBE/SBE firm. Good cause includes the following circumstances:

1. The listed DBE/SBE fails or refuses to execute a written contract.

2. The listed DBE/SBE fails or refuses to perform the work of its subcontract in a way consistent with normal industry standards. Provided, however, that good cause does not exist if the failure or refusal of the DBE/SBE to perform its work on the subcontract results from the bad faith or discriminatory action of the Contractor.

3. The listed DBE/SBE fails or refuses to meet the Contractor's reasonable, nondiscriminatory bond requirements.

4. The listed DBE/SBE becomes bankrupt, insolvent, or exhibits credit unworthiness.

5. The listed DBE/SBE is ineligible to work on public works projects because of suspension and debarment proceedings pursuant to 2 CFR Parts 180, 215 and 1200 or applicable state law.

6. The Department has determined the listed DBE/SBE is not a responsible contractor.

7. The listed DBE/SBE voluntarily withdraws from the project and provides to the Contractor and the Department written notice of its withdrawal.

8. The listed DBE/SBE is ineligible to receive DBE/SBE credit for the type of work required.

9. A DBE/SBE owner dies or becomes disabled with the result that the listed DBE/SBE contractor is unable to complete its work on the contract.

10. Other documented good cause that you determine compels the termination of the DBE/SBE. Provided, that good cause does not exist if the Contractor seeks to terminate a DBE/SBE it relied upon to obtain the contract so that the Contractor can self-perform the work for which the DBE/SBE was engaged or so that the Contractor can substitute another DBE/SBE or non-DBE/non-SBE after contract award.

The Contractor shall give notice in writing to the DBE/SBE and the Department of its intent to request to terminate or substitute a DBE/SBE, and the reason for the request. The Contractor shall give the DBE/SBE 5 days to respond to the Contractor's notice and advise the Department and the Contractor of the reasons, if any, why it objects to the proposed termination of its subcontract and why the termination should not be approved. If required in a particular case as a matter of public necessity, the Department may provide a response period shorter than 5 days.

When a DBE/SBE subcontractor is terminated, or fails to complete its work on the contract for any reason, the Contractor will make good faith efforts to find another DBE/SBE subcontractor to substitute for the original DBE/SBE. These good faith efforts shall be directed at finding another DBE/SBE to perform at least the same amount of work under the contract as the DBE/SBE that was terminated, to the extent needed to meet the contract goal.

**108.02 Notice to Proceed.** An official "Notice to Proceed" specifying the date by which construction operations shall be started will be issued. Commence work not later than the date set forth in the "Notice to Proceed." The date set forth in the "Notice to Proceed" shall not be less than 30 days after the "Notice to Proceed" is issued. Do not begin work before the date set forth in the "Notice to Proceed" unless requesting such in writing and receiving permission. In no case, however, begin work before the date of approval of the contract. Contract time will begin on the date specified in the "Notice to Proceed," unless operations begin at an earlier date, in which case the date that such operations were begun will apply.

The Department may issue the "Notice to Proceed" at the time it issues the "Notice of Award" of the contract. In this case, the time set forth in the "Notice to Proceed" will run while the contract is being signed by all parties.

**108.03 Prosecution and Progress.** (a) General. After being awarded the contract, prepare and submit for acceptance the progress schedules as specified herein showing the order in which the work is proposed to be carried out.

Do not construe the approval of any progress schedule submitted to assign responsibility of performance or contingencies to the Department or relieve responsibility to adjust forces, equipment, and work schedules as may be necessary to insure completion of the work within prescribed contract time. Regardless of the number of working days or completion date indicated on the schedules, liquidated damages will be assessed according to Subsection 108.09.

Any contingency (difference in time between the projects early completion and required contract completion date) in a progress schedule belongs to the project, not any one party to the contract.

Neither the Contractor nor the Engineer shall own the "slack" or "float," which is the amount of time between the early start date and the late start date, or the early finish date and the late finish date, of any activity or group of activities in the schedule.

The progress schedule may be used as a basis for establishing major construction operations and as a check on the progress of work. Provide sufficient materials, equipment, and labor to guarantee the completion of the project according to the plans and specifications within the prescribed contract time. Should the prosecution of the work for any reason be discontinued, give notification at least 24 hours in advance of resuming operations.

In addition to hard copies of plots and reports, submit electronic copies of the schedules. Acceptable formats for the preliminary schedule include bar chart, Gantt chart, arrow diagram (activity on arrow), precedence diagram, pure logic diagram (activity on node), or time-scaled logic diagram. Provide electronic copies of the baseline, monthly updates, and supplemental schedule files in an approved compatible format which can be accessed by the Department's current version of "Primavera" software scheduling program. The submittal of satisfactory progress schedules including preliminary, baseline, monthly updates, and supplemental schedules shall be considered as a necessary portion of the work; therefore, partial payments as set forth under Subsection 109.06 may not be forthcoming until this requirement is complied with.

The supplemental schedules and monthly updates shall not alter the logic previously established in the preliminary schedule or baseline schedule unless requested and approved in writing.

(b) Preliminary Schedule. Submit 4 copies of a preliminary schedule within 14 days of the "Notice of Award," and no later than 7 days before the Preconstruction Conference. As a minimum, show the first 30 working days on this schedule, including such activities as mix designs, procurement, shop drawings, aggregate source acceptance, material sampling, mix design preparation, fabrication, submittals, mobilization, demobilization, and activities or phases of work.

Allow 10 days for review and acceptance or rejection of the preliminary schedule. Participate in a review and evaluation of the preliminary schedule with the Engineer, as requested. Provide requested revisions to the preliminary schedule within 10 days.

(c) Baseline Schedule. Within 15 days after acceptance of the preliminary schedule, submit 4 copies of a baseline schedule. Designate at the time of the baseline schedule submittal, in writing, an authorized representative who will be responsible for the preparation, revision, and updating of the baseline schedule. Allow 15 days for review and acceptance or rejection of the baseline schedule. Participate in a review and evaluation of the baseline schedule with the Engineer, as requested. Provide requested revisions to the baseline schedule within 10 days.

Provide a graphic network diagram showing the elements of the project in detail and an entire project summary. Show the order and interdependence of activities and the sequence in which the work is to be accomplished. Include the description, activity number, estimated duration in working days, and all activity relationship lines for each activity in the graphic network diagram. Provide sufficient detail to allow day-to-day monitoring of proposed operations. Activity durations shall not exceed 10 working days in length. Exceptions would include procurement activities and work activities which may be considered routine once they are commenced. Provide a plot of the schedule in an acceptable size, scale, and format. Show the order and interdependence of activities and the sequence of work. Prominently distinguish critical activities on all reports by the use of color or other acceptable means. Successors may not be required for certain activities which are not on the critical path, if it can be reasonably assumed that the activity in question is not critical and must be completed sometime before project completion.

Provide a mathematical analysis of the network diagram which includes the following information as a minimum for each activity:

1. Preceding and succeeding event numbers.
2. Activity description and number.
3. Estimated duration of activities.
4. Early start date (by calendar date).
5. Early finish date (by calendar date).
6. Late start date (by calendar date).
7. Late finish date (by calendar date).
8. Slack or float.
9. Activity constraints.

If the precedence technique is used, submit a schedule report which includes a calendar in working days, a network report sorted by early start, a network report sorted by total float, and a logic table report sorted by work item which indicates the complete preceding and succeeding logic ties. If the arrow technique is utilized, submit a schedule report which includes a calendar in working days, a network report sorted by early start, a network report sorted by I-J numbers, and a network report sorted by float time and I-J numbers.

In the event that an early completion schedule is submitted either party may request a contract change order to modify Subsection 108.02 to reflect the early completion. If a contract change order is not executed the parties agree that the "slack" or "float" shown by the early completion schedule remains with the project and to waive rights to any damages for failing to complete the project in the time shown on the early completion schedule. A baseline schedule submitted that exceeds the time frames shown in Subsection 108.02 may be accepted at the discretion of the Engineer, however, any actual work that exceeds these time frames without an executed change order increasing time will be subject to the provisions of Subsection 108.09.

(d) Monthly Updates. Submit monthly updates on projects over 120 working days duration. Submit monthly updates prior to the end of the month. Provide tabulation reports for activity numbers, total float, early start, and for precedence schedules, and a logic report of proceeding and succeeding activities with all restraints indicated. Provide a report showing the activities, or portions of activities, completed during the reporting period. State the

percentage of the work actually completed and scheduled, the remaining duration, and the progress along the critical path in terms of days ahead or behind the allowable dates as of the report date. Indicate any changes made to the baseline schedule.

In the event that an early completion schedule is submitted, either party may request a contract change order to modify Subsection 108.02 to reflect the early completion. If a contract change order is not executed the parties agree that the “slack” or “float” shown by the early completion schedule remains with the project and to waive rights to any damages for failing to complete the project in the time shown on the early completion schedule.

(e) Supplemental Schedule. Submit a supplemental schedule if, the project is determined to be behind schedule as requested by the Engineer. Include a revised network diagram and mathematical analysis showing the proposed revised baseline schedule. The conditions under which revisions of the baseline schedule will be required include the following:

1. When delay in completion of any work item or sequence of work items results in an estimated extension of project completion by either 20 working days or 5% of the remaining duration of time to complete the project, whichever is less.

2. When delays in submittals or deliveries make replanning or rescheduling of the work necessary.

3. When the schedule does not represent actual prosecution and progress of the work.

4. When any change to the sequence of activities, the completion date for major portions of the work, or changes occur which affect the critical path.

5. When contract modification necessitates schedule revision.

**108.04 Limitation of Operations.** Conduct the work at all times in such a manner and in such sequence as will assure the least interference with traffic. Provide due regard to the location of detours and to the provisions for handling traffic. Do not open up work to the prejudice or detriment of work already started. Finishing a section on which the work is in progress may be required before work is started on any additional sections if the opening of such section is essential to public convenience.

No work will be required on Saturdays, Sundays, or State recognized holidays. If, however, electing to work on such days, those days worked will be charged as working days. Give notice of intention to work on the aforementioned days at least 48 hours in advance of such work. State recognized holidays are enumerated in Subsection 101.03, for “Holidays.”

The Engineer may give notification in writing and require cessation of construction operations the day before, during, and the day after said holidays, or at any other time if operations are of such nature, the project is so located, and traffic is of such volume that it is deemed expedient to do so.

Give notification in writing 48 hours prior to beginning night shift work (8:00 p.m. to 6:00 a.m.) or double shift operations.

Do not permit traffic on any part of the completed prime coat, plantmix bituminous surface, plantmix bituminous open-graded surface, seal coat, cement treated base or Portland cement concrete pavement until authorized.

During nonworking hours, park vehicles and equipment a minimum of 9 m (30 ft) from the pavement edge of the traveled way over which public traffic is directed unless separated by guardrail or concrete barrier rail.

Locate employee parking within “cleared” right of way and a minimum of 9 m (30 ft) from the pavement edge of the traveled way over which public traffic is directed unless separated by guardrail or concrete barrier rail.

Do not store or stockpile materials and supplies within 9 m (30 ft) of a travel lane unless separated by guardrail or concrete barrier rail.

Do not dispose of concrete slabs, concrete foundations, old bituminous surfacing, or other debris in median or interchange quadrant areas.

Do not remove existing fence until new or temporary fences have been constructed in a manner that will prevent pedestrians, children, livestock, or pets from entering upon or crossing the right of way or straying from their

appointed area. Provide such additional temporary fencing and gates as may become necessary to properly control such movement during construction. Such temporary fencing and gates will not be measured for payment but the cost thereof shall be considered as included in the contract unit price bid for other items of work.

Carry out installation of cross drainage pipe which carry water for irrigation or stockwater purposes so as to provide for a minimum delay of water service. Make satisfactory arrangements with the users of the water relative to their needs for such purposes.

Sequence construction activities to perpetuate historic flow patterns and conveyances for both temporary and permanent flow. Temporary conveyance is at the expense of the Contractor and shall be safely conveyed to a reasonable and safe outfall location.

Give notification in writing 18 hours in advance of any major deck pour. At this time the portion of the deck to be poured shall be complete and ready to accept concrete. At the discretion of the Engineer, minor deficiencies may be corrected during this 18 hour period.

Before placing any plantmix bituminous material, deliver and place shouldering material on the shoulders ahead of the paving operation. Spread and compact shouldering material in a manner that will accommodate emergency parking for public traffic.

Limit paving operation so that the shouldering up operation is not more than one day behind the placement of the final lift of dense-graded plantmix bituminous surface. To accomplish this, place shouldering material to the finished side slopes so that the shouldering material is flush with the top of the new dense-graded plantmix bituminous surface. If more than 2 lifts of dense-graded bituminous surface are to be placed, and traffic is allowed to use the roadway, blade up shouldering material flush with the top of the second lift of the new dense-graded bituminous surface within one day after the placement of the second lift of the dense-graded bituminous surface.

Shoulder up again after placement of the plantmix bituminous open-graded surface.

See Section 624 regarding accommodations for public traffic.

Remove existing mailboxes and install new mailboxes in a manner that will not disrupt or prevent the U.S. Postal Service from mail pick up or delivery.

During the removal and installation of cattle guards and culvert pipes, maintain access for public traffic.

Remove and install cattle guards and culvert pipes one-half roadway width at a time. Once the work is started on the removal and/or installation of the cattle guard and culvert pipe, work diligently and continuously until all lanes of traffic can safely accommodate public traffic.

Remove only as much guardrail as can be replaced during the same shift, or protect the area with portable precast concrete barrier rail at no direct payment.

Place plantmix ramps with a minimum of 1:50 (50:1) transition before opening to public traffic where cold milling is adjacent to cross streets and permitted approaches.

Perform concrete work prior to cold milling/paving adjacent travel lanes.

During removal and reconstruction of the curb ramps, maintain alternate pedestrian access at all times. Backfill all drop offs at excavations for the curb ramps with aggregate base in the event the concrete is not replaced within the next day. Complete the curb ramps at the intersections one quadrant at a time, so that pedestrian traffic is allowed at the other three quadrants. Do not work on more than 4 consecutive sidewalk ramps at one time. Complete and reopen the ramp to the public within 2 days following the removal. Failure to comply with this time constraint will result in the assessment of liquidated damages according to Subsection 108.09.

**108.05 Character of Workers; Methods and Equipment.** At all times employ sufficient labor and equipment for prosecuting the several classes of work to full completion in the manner and time required by these specifications.

Use workmen of sufficient skill and experience to perform properly the work assigned to them. Provide workmen engaged in special or skilled work of sufficient experience in such work and in the operation of the equipment required to perform all work properly and satisfactorily.

Remove forthwith at written request, any person employed who, does not acceptably perform his work in a proper and skillful manner or is intemperate or disorderly, and do not employ again in any portion of the work without approval.

For failure to remove such person or persons as required above, or failure to furnish suitable and sufficient personnel for the proper prosecution of the work, the work may be suspended by written notice until such orders are complied with.

All personnel within the Department's right of way shall wear vests meeting Vest Pattern 3 (Performance Class 2) or coveralls/jumpsuits meeting Performance Class 3 requirements set forth in ANSI/ISEA 107-2004 "American National Standard for High-Visibility Safety Apparel and Headwear." Garment stripes shall consist of retroreflective material of a contrasting color of silver, white, or fluorescent yellow-green. The apparel shall bear the manufacturer's marking label according to the requirements set forth in ANSI/ISEA 107-2004.

Provide equipment of sufficient size and in such mechanical condition as to meet requirements of the work and to produce a satisfactory quality of work. Use equipment which does not cause injury to the roadway, adjacent property or other highway from its use.

When the methods and equipment to be used in accomplishing the construction are not prescribed in the contract, use any methods or equipment that satisfactorily demonstrates they will accomplish the contract work in conformity with the requirements of the contract.

When the contract specifies that the construction be performed by the use of certain methods and equipment, use such methods and equipment unless others are authorized. To receive such authorization, submit request in writing and include a full description of the methods and equipment proposed to be used and an explanation of the reasons for desiring to make the change. If approved, it will be on the condition that work shall be produced in conformity with contract requirements. If, after trial use of the substituted methods or equipment, it is determined that the work produced does not meet contract requirements, discontinue the use of the substitute method or equipment and complete the remaining construction with the specified methods and equipment. Remove the deficient work and replace it with work of specified quality, or take such other corrective action as directed. No change will be made in basis of payment for the construction items involved nor in contract time as a result of authorizing a change in methods or equipment under these provisions.

See NRS 338.125 and NRS 613.250.

For failure to comply with NRS 338.130, the contract will be subject to termination according to Subsection 108.10.

**108.06 Temporary Suspension of Work.** The Engineer will have the authority to suspend the work wholly or in part, for such period as he may deem necessary, due to unsuitable weather or to such other conditions as are considered unfavorable for the suitable prosecution of the work, or for such time as he may deem necessary due to the failure on the part of the Contractor to carry out orders given, or to perform any provision of the contract. Immediately comply with the written order to suspend the work wholly or in part. Resume the suspended work when conditions are favorable and methods are corrected, as ordered or approved in writing.

Maintain the roadway during suspension of the work when such suspensions are due to the Contractor's negligence. During any other suspension, make passable and open to traffic such portions of the project and temporary roadways or portions thereof as may be agreed upon between the Contractor and the Engineer for the temporary accommodation of traffic during the anticipated period of suspension. Thereafter, and until an issuance of an order for the resumption of construction operations, the maintenance of the temporary route or line of travel agreed upon will be by and at the expense of the Department. Such maintenance and responsibility will include and be restricted to the traveled roadway for the convenience of public travel; opening plugged pipes and roadway ditches and drains; or correcting any other hazard which may be detrimental to adjacent property owners or the traveling public. When work is resumed, replace, renew, and repair any work or materials lost or damaged because of such temporary use of the project regardless of the cause of such damage or loss, except as provided in Subsection 107.15. The Department is in no way responsible to maintain the roadway and appurtenances in any certain condition or state of repair. Complete the project in every respect as though its prosecution had been continuous and without interference.

If a suspension of work is ordered by reason of the failure to carry out orders or to perform any provision of the contract, or by reason of weather conditions being unsuitable for performing any item or items of work, which work, could have been performed before the occurrence of such unsuitable weather conditions had the work been

diligently prosecuted when weather conditions were suitable, perform all the work necessary to provide a safe, smooth and unobstructed passageway through construction for use by public traffic during the period of such suspension as provided in Subsection 107.07, and as specified in the Special Provisions for the work. For failure to perform the work above specified, the Department will perform such work and the cost thereof will be deducted from money due or to become due.

If a suspension of work is ordered due to unsuitable weather conditions, and the work was prosecuted with energy and diligence before the time that operations were suspended, the cost of providing a smooth and unobstructed passageway through the work will be paid for as extra work as provided in Subsection 104.03, or at the option of the Engineer, such work will be performed by the Department at no cost to the Contractor.

If ordered to suspend all of the work or a portion of the work which is the current controlling operation or operations, due to unsuitable weather or to such other conditions as are considered unfavorable to the suitable prosecution of the work, the days on which the suspension is in effect shall not be considered working days as defined in Subsection 101.03, for “Working Day.” If a portion of work at the time of such suspension is not a current controlling operation or operations, but subsequently does become the current controlling operation or operations, the determination of working days will be made on the basis of the then current controlling operation or operations.

If a suspension of work is ordered, due to the failure to carry out orders given or to perform any provision of the contract, the days on which the suspension order is in effect shall be considered working days if such days are working days within the meaning of the definition set forth in Subsection 101.03, for “Working Day.”

A suspension of work under any of the conditions set forth in this Section, shall not relieve the responsibilities as set forth in Section 107.

Requests for additional compensation due to the ordered suspension of work shall be based on the following:

(a) If the performance of work is suspended or delayed by written order for an unreasonable period of time (not originally anticipated, customary, or inherent to the construction industry) and believing that additional compensation and/or contract time is due as a result of such suspension or delay, submit in writing a request for adjustment within 7 days of receipt of the notice to resume work. The request shall set forth the reasons and support for such adjustment.

(b) Upon receipt, the request will be evaluated. If agreed that the cost and/or time required for the performance of the contract has increased as a result of such suspension and the suspension was caused by conditions beyond the control of and not the fault of the Contractor, its suppliers, or subcontractors at any approved tier, and not caused by weather, an adjustment (excluding profit) and modification to the contract will be made in writing accordingly. Notification of the determination of whether or not an adjustment of the contract is warranted will be made.

(c) No contract adjustment will be allowed unless the request for adjustment was submitted within the time prescribed.

(d) No contract adjustment will be allowed under this clause to the extent that performance would have been suspended or delayed by any other cause, or for which an adjustment is provided for or excluded under any other term or condition of this contract.

**108.07 Preconstruction Conference.** After the contract has been awarded and before commencing work, the Engineer may designate a time and place satisfactory to the Contractor for a preconstruction conference. At such time the detailed requirements will be outlined to be followed in performance of the contract.

**108.08 Determination and Extension of Contract Time.** The contract time for completion will be fixed by the Department, and will be stated in the Special Provisions, either as a calendar date or based on a number of working days. See Subsection 101.03, for “Working Day.”

Perform the work in an acceptable manner within the time stated in the contract except that the contract time for completion may be adjusted as follows:

(a) Based on the merits of specific circumstances encountered during the term of the contract, the Engineer may adjust the contract time allowed to complete the work. Any such adjustment of time shall be in writing.

(b) In case of ordered suspension of major items of work and through no fault of the Contractor, the time for completion shall be extended an amount equal to the elapsed time between effective dates of order to suspend and order to resume.

(c) When delays occur due to unforeseen causes beyond the control and without the fault or negligence of the Contractor, including, but not restricted to acts of God, acts of the public enemy, acts of government agency, fires, floods, epidemics, strikes and freight embargoes, the time for completion shall be extended an amount determined to be equivalent to the delays; provided, however, written request for such extension of time is made within 10 days after the beginning of such delay. No allowance shall be made for delay or suspension of the work due to fault of the Contractor.

Certain critical materials such as, steel, copper, aluminum and bituminous products may be difficult to obtain due to a nationally recognized shortage or defense needs. Make every reasonable effort necessary to order and procure all such critical materials sufficiently in advance so as not to delay the completion of the project. Should a delay occur in obtaining critical materials that were properly ordered, the time for completion of the contract may be extended an amount determined to be equivalent to the delay in project progress due to said delay in obtaining critical materials provided:

(a) The delay in furnishing critical materials was due to defense needs or nationally recognized shortage.

(b) That satisfactory evidence is furnished that adequate steps were taken for a guaranteed delivery date from his supplier.

(c) That paragraph "(a)" above is properly certified to by not less than three suppliers of the material. If three suppliers are not available, so certify and supply certification from such suppliers as there are.

(d) That the Department does not find a source when notified of the shortage by the Contractor.

(e) That such material is obtained from the first source available after such certification.

The contract time shall begin as set forth in Subsection 108.02. When the final acceptance has been duly made as prescribed in Subsection 105.16, the daily time charge shall cease.

Working days will not be charged for seeding deposit areas, haul roads and that work set forth in Subsection 104.05, provided that all other work has been completed.

**108.09 Failure to Complete the Work on Time.** Time is an essential element of the contract and it is important that the work be pressed vigorously to completion. The cost to the Department of the administration of the contract, including engineering, inspection, and supervision will be increased as the time occupied in the work is lengthened. The public is subject to detriment and inconvenience when full use cannot be made of an incomplete project.

For failure to complete the work within the time specified in the contract or within such extra time as may have been allowed by increases in the contract or by formally approved extensions granted by the Department, there will be deducted from any money or amounts due or that may become due, the sum set forth in the Special Provisions for each and every working day that the work remains uncompleted. This sum shall be considered and treated not as a penalty but as liquidated damages due the State by reason of inconvenience to the public, added cost of engineering and supervision and other items which have caused an expenditure of public funds resulting from his failure to complete the work within the time specified in the contract.

Permission to continue and finish the work or any part of it after the time fixed for its completion, or after the date to which the time for completion may have been extended, will in no way operate as a waiver on the part of the Department of any of its rights under the contract.

Working days normally will not be charged for seeding deposit areas, haul roads, and that work set forth in Subsection 104.05 provided that all other work has been completed.

However based upon presumptive completion of all pay items, as determined by the Engineer, 30 days or 10% of the contract working days, whichever is greater, will be allowed to perform final clean up. If all work required in Subsection 104.05 is not finished within the above time charging of working days will be resumed until the final clean up has been completed.

**108.10 Default and Termination of Contract.** If the Contractor:

(a) Fails to begin the work under the contract within the time specified in the Notice to Proceed, or

(b) Fails to perform the work with sufficient workmen and equipment or with sufficient materials to assure the prompt completion of said work, or

(c) Performs the work unsuitably or neglects or refuses to remove materials or to perform such work as may be rejected as unacceptable and unsuitable, or

(d) Discontinues the prosecution of the work, or

(e) Fails to resume work which has been discontinued within a determined time after notice to do so, or

(f) Becomes insolvent or is declared bankrupt or commits any act of bankruptcy or insolvency, or

(g) Allows any final judgment to stand against him unsatisfied for a period of 5 days, or

(h) Makes an assignment for the benefit of creditors, or

(i) Fails to comply with contract requirements regarding minimum wage payments or Equal Employment Opportunity requirements, or

(j) For any other cause whatsoever, fails to carry on the work in an acceptable manner, notice will be given in writing to the Contractor and his surety of such delay, neglect or default.

If the Contractor or surety, within a period of 10 days after such notice, shall not proceed in accordance therewith, then the Engineer shall have full power and authority without violating the contract, to take the prosecution of the work out of the hands of the Contractor. The Engineer may, at his option, call upon the surety to complete the work according to the terms of the contract; or he may take over the work, including any or all materials and equipment on the project as may be suitable and acceptable, and may complete the work by force account, or may enter into a new agreement for the completion of said contract according to the terms and provisions thereof, or use such other methods as, in his opinion, will be required for completion of said contract in an acceptable manner.

All costs and charges incurred by the Department, together with the cost of completing the work under the contract, will be deducted from any money due or which may become due. In case the expense so incurred by the Department is less than the sum which would have been payable under the contract if it had been completed by said Contractor, then said Contractor shall be entitled to receive the difference. In case such expense exceeds the sum which would have been payable under the contract, then the Contractor and his surety shall be liable and shall pay to the State the amount of said excess.

The contract or any portion thereof may also be ordered terminated in writing after determining that, for reasons beyond either Department or Contractor control, the Contractor is prevented from proceeding with or completing the work as originally contracted for, and that termination would therefore be in public interest. Such termination must be with the concurrence of the Board of Directors and with the approval of the FHWA when applicable.

If a contract, or a portion thereof, is terminated, it shall be subject to the following conditions:

(a) Completed items of work as of the date of termination will be paid for at the contract bid price. Payment for partially completed work will be made either at agreed prices or by force account methods described elsewhere in these specifications. Items which are eliminated in their entirety by such termination will be paid for as provided in Subsection 104.02. In no event will loss of anticipated profits be considered as part of any settlement.

(b) Acceptable materials obtained or ordered by the Contractor for the work and that are not incorporated in the work shall, at the option of the Contractor, be purchased from the Contractor based upon the delivered cost of the materials at such points of delivery as may be designated. Do everything possible to cancel unfilled orders.

(c) Termination of a contract or a portion thereof shall not relieve the Contractor of his responsibilities for the work completed nor shall it relieve his surety of its obligation for and concerning any claims arising out of the work performed.

(d) Submit any claim for loss or damages not covered above or elsewhere in these specifications within 60 days after receipt of the Order of Termination by the Contractor for the Director's acceptance or rejection. It is the intent of this Subsection that an equitable settlement between the parties be reached pursuant to negotiation.

**108.11 Termination of the Contractor's Responsibility.** Whenever the improvement contemplated and covered by the contract is completely performed and all parts of the work have been approved and accepted, according to the contract, and the final progress payment paid, obligations shall then be considered fulfilled, except as set forth in the contract bond and as provided in Subsection 107.11.

**108.12 Right of Way Delays.** If, through the failure of the State to acquire or clear right of way, a loss is sustained which could not have been avoided by the judicious handling of forces, equipment and plant, there will be paid to the Contractor such amount as may be found to be a fair and reasonable compensation for such part of the actual loss, as, in the opinion of the Engineer, was unavoidable, determined as follows.

Compensation for idle time of equipment will be determined in the same manner as determinations are made for equipment used in the performance of extra work paid for on a force account basis, as provided in Subsection 109.03, with the following exceptions:

(a) The time for which such compensation will be paid will be the actual normal working time during which such delay condition exists, but in no case will exceed 8 hours in any one day.

(b) The days for which compensation will be paid will be the working days charged to the contract except that no compensation will be paid for Saturdays, Sundays or holidays regardless of working days charged.

Understand actual loss to include no items of expense other than idle time of equipment and necessary payments for idle time of men, cost of extra moving of equipment, and cost of longer hauls. Compensation for idle time of equipment will be determined as provided in this Subsection and compensation for idle time of men will be determined as provided in Subsection 109.03, and no markup will be added in either case for overhead and profit.

If performance of work is delayed as the result of the failure of the Department to acquire or clear right of way, an extension of time determined pursuant to the provisions in Subsection 108.08, will be granted.

**108.13 National Emergency and Termination of Contract.** The State may, by written notice, with the approval of the FHWA where applicable, terminate the contract or a portion thereof when the Contractor is prevented from proceeding with the construction contract as a direct result of an Executive Order of the President with respect to the prosecution of war or in the interest of national defense.

When contracts, or any portion thereof, are terminated before completion of all items of work in the contract, payment will be made for the actual number of units or items of work completed at the contract unit price, or as mutually agreed for items of work partially completed or not started. No claim for loss of anticipated profits will be considered.

Reimbursement for organization of the work (when not otherwise included in the contract) and moving equipment to and from the job will be considered where the volume of work completed is too small to compensate for these expenses under the contract unit prices, the intent being that an equitable settlement will be made.

Acceptable materials, obtained for the work, that have been inspected, tested and accepted, and that are not incorporated in the work may, at the option of the Engineer, be purchased at actual cost as shown by receipted bills and actual cost records at such points of delivery as may be designated.

Termination of a contract or a portion thereof shall not relieve the responsibilities for the completed work, nor shall it relieve surety of its obligation for and concerning any just claims arising out of the work performed.

# SECTION 109

## MEASUREMENT AND PAYMENT

**109.01 Measurement of Quantities.** The measurement and determination of the number of units of each pay item will be made in general as prescribed hereinafter and specifically as set out under the “measurement” Subsection of the Section for each pay item.

Unless otherwise specified, measurement will be made when the work is in place, complete, and accepted, measurements will be made of the actual work performed, except work outside the design limits or other adjusted or specified limits (staked limits) will not be measured. Structures will be measured to the neat lines shown on the plans or to approved lines that have been adjusted to fit field conditions.

After the items of work are completed and before final payment is made, the quantities of the various items of work performed will be determined as the basis for final settlement for all other than lump sum contracts. In the case of unit price items, the actual amount of work performed and materials used will be paid for according to these specifications, as shown by the final measurements, unless otherwise specified.

Actual authorized quantities of work satisfactorily completed under the contract will be measured according to International System of Units (SI) measures for metric unit contracts, and United States Standard Measures for English unit contracts. Unauthorized wasting of material will be deducted and only such quantities as are actually incorporated in the completed work will be included in the final progress payment.

Unless otherwise specified, longitudinal measurements for area computations will be made horizontally and no deductions will be made for individual fixtures having an area of 1 $m^2$ (9 $ft^2$) or less. Unless otherwise specified, transverse measurements for area computation will be the neat dimensions shown on the plans or ordered in writing.

In computing volumes of excavation, embankment and borrow, the average end area method will be used unless otherwise specified.

All items which are measured by the linear meter (linear foot) such as pipe culverts, underdrains, guardrails, etc., will be measured parallel to the base or foundation upon which such structures are placed, unless otherwise shown on the plans.

When water meters are required, the accuracy of the meters will be checked by comparing the actual mass of approximately 4,000 L (1,000 gal), or 4 $m^3$ (125 $ft^3$), as metered with the calculated mass using as a reference density 1.00 kg/L (8.33 lb/gal) or 1,000 kg/$m^3$ (62.4 lb/$ft^3$ ). Unless otherwise specified, provide water meters accurate to within 2% of the indicated amount. The frequency of checking water meters will be determined.

The term “metric ton” shall mean 1,000 kg. The term “ton” shall mean the short ton consisting of 2,000 lb avoirdupois. Weigh all materials which are specified for measurement by the metric ton (ton) on certified scales set at designated locations. Weigh all materials on platform scales with the following exception: In lieu of platform scales, provide an automatic printer system which will print the masses of the material delivered, provided the system is used in conjunction with an approved automatic batching control system. Such evidence shall be evidenced by a weigh ticket for each load. Provide not less than ten 25 kg (50 lb) standard masses for testing the scales.

Furnish scales with a certificate of inspection by the Bureau of Weights and Measures. The scales shall be tested and inspected by the Bureau of Weights and Measures and a new inspection certificate required every twelve months or as often as deemed necessary, and after each scale move, in order to insure the accuracy of the scales. The cost of the initial scale inspection will be borne by the Department. Additional inspections shall be at own expense. Notify the Engineer a minimum of 10 working days before the date needing a scale inspection. The Engineer will verify the scale is ready for inspection and notify the Bureau of Weights and Measures.

Provide platform scales of sufficient size and capacity to weigh, in one operation, the entire loaded vehicle. Combination vehicles may be weighed as separate units, provided the connecting device between vehicles is so constructed that no mass other than that of the device itself is transmitted to either vehicle. When combination vehicles are used, level approaches to and from the scale platform for sufficient distance to accommodate that portion of the combination vehicle that is off the scale platform. In instances where combination vehicles are weighed, level the approaches to and from the scale platform with the scale platform for a minimum distance of 15 m (50 ft) from each end of the scale platform.

For determining pay quantities provide automated scales that print delivery tickets with gross weight, tare weight, net weight, accumulated total, date, pit description, description of material, and contract number. The automated scale software shall be capable of handling multiple bid items.

If combination vehicles are utilized, make provisions to insure that all braking devices are disengaged during weighing operations as insurance against stresses being transmitted between either vehicle.

Construct the scale pit of sufficient width to permit access to all scale components for purposes of inspection, repair, cleaning, and adjusting.

Use support members for platform scales per the manufacturers recommendations.

Equip platform scales with weatherproof housing so constructed as to protect the recording device and permit the weighmaster convenient access to all beams and dials. Provide housing not less than 1.8 m (6 ft) wide, 2.4 m (8 ft) long and 2.1 m (7 ft) high, and with 2 windows, adjustable for ventilation, one facing the scales, and equip with a suitable shelf. Provide heating, cooling, and electric lights when requested.

A hopper weight system of an approved type may be used. Furnish the hopper weight system with one master counter to run continuously and one remote counter which will print the mass in individual loads, then reset to zero automatically. Place the remote unit in a weatherproof house with 2 windows. One window shall face the point of loading and the hopper weight system. Also equip this window with a suitable shelf. Supply a controlled method of heating for cold weather operations.

If a hopper weight system is used, adhere to the following procedures:

(a) Calibrate the hopper weight system against the platform scales, which must have a certificate of inspection.

(b) At the beginning and middle of each shift, or as requested, reweigh 2 consecutive loads of material weighed over the hopper weight system on the platform scales. The total mass indicated by the hopper weight system on the 2 loads must check with the platform scale mass within 0.5%. If the hopper weight system weigh out of this tolerance, weigh all loads on the platform scales until the condition is rectified.

(c) Use consecutively numbered, individual weigh tickets with the hopper weight system masses stamped by the remote counter.

Unless otherwise specified, weigh materials shipped by rail over the authorized project scales before incorporation into the work.

Timber will be measured by the cubic meter (1,000 feet board measure, Mfbm) actually incorporated in the structure with no allowance for any waste except beveled ends. Measurement will be based on nominal widths and thicknesses, and the extreme length of each piece.

When a complete structure or structural unit (in effect, “lump sum” work) is specified as the unit of measurement, the unit will be construed to include all necessary fittings and accessories.

Haul materials for which measurements are obtained by the cubic meter (cubic yard) “loose measurement” or “measured in the vehicle” in approved vehicles and measured therein at the point of delivery. No allowance will be made for the settlement of material in transit. Vehicles for this purpose may be of any acceptable size or type, provided that the body is of such shape that the actual delivered contents may be readily and accurately determined and will remain constant. Unless all approved vehicles on the work are of uniform capacity, each vehicle must bear a plainly legible identification mark, indicating its specified approved capacity. Load all vehicles to at least their water level capacity and level loads when the vehicles arrive at the point of delivery. Loads not hauled in approved vehicles or of a quantity less than the specific approved quantity for the hauling vehicle will be subject to rejection and no compensation will be allowed for the hauling of the material.

The unit of measurement for cutback asphalts, emulsified asphalts, and asphalt cements, when specified to be measured for payment, will be by the metric ton (ton) or liter (gallon).

Quantities of bituminous binders wasted or disposed of in a manner not called for under these specifications, or remaining on hand after completion of the work, will not be paid for.

When permitted, pay quantities of bituminous binder may be determined from volumetric measurements of the bituminous binder, in which case deliver the bituminous binder in calibrated tanks and accompany each tank with its proper measuring stick and a calibration card signed by a sealer of weights and measures and pay quantities will be determined by the following procedure.

The tank and stick calibrations shall be in English units for English unit contracts and metric units for metric unit contracts. Reduce volumetric measurements at any temperature to the volume the material would occupy at 15.6 °C (60 °F), before converting the volumetric measurements to mass.

Use the following tables to convert volumes from liters (gallons) to mass:

**Average Masses and Volumes of Cutback Asphalt at 15.6 °C (60 °F)**

| Grade MC or SC | L/metric ton (Gal/ton) | kg/L (lb/gal) |
|---|---|---|
| 70, 70NV | 1,056 (253) | 0.947 (7.9) |
| 250 | 1,039 (249) | 0.959 (8.0) |
| 800 | 1,022 (245) | 0.983 (8.2) |
| 3000 | 1,005 (241) | 0.995 (8.3) |

**Average Masses and Volumes of Asphalt Cement at 15.6 °C (60 °F)**

| Grade | L/metric ton (Gal/ton) | kg/L (lb/gal) |
|---|---|---|
| PG 58-28, PG 64-16, PG 64-22, PG 64-28NV | 981 (235) | 1.019 (8.5) |
| PG 64-28NVTR, PG 70-16, PG 76-22NV | 977 (234) | 1.025 (8.55) |
| PG 76-22NVTR | 972 (233) | 1.031 (8.6) |

**Average Masses and Volumes of Emulsified Asphalt at 15.6 °C (60 °F)**

| Type | L/metric ton (Gal/ton) | kg/L (lb/gal) |
|---|---|---|
| All grades | 1,005 (241) | 0.995 (8.3) |

When converting the volume of cutback asphalt, asphalt cement, or emulsified asphalt at any temperature to the volume at 15.6 °C (60 °F) use a conversion factor for correlation. Said conversion factors shall be those prescribed in “The Asphalt Institute” publication of “Manual Series No. 6.”

Rental of equipment will be measured by time within 0.5 hours of actual working time and necessary traveling time of the equipment within the limits of the project. If equipment has been ordered on the job on a standby basis, half-time rates for the equipment will be paid.

When special equipment has been ordered in connection with force account work, travel time and transportation to the project will be measured as hereinafter outlined. For the use of special equipment moved in on the work and used exclusively for extra work paid for on a force account basis, the rental rates determined as provided in Subsection 109.03, and the cost of transporting the equipment to the location of the work and its return to its original location will be paid, all according to the following provisions:

(a) The original location of the equipment to be hauled to the location of the work will be agreed to in advance.

(b) The State will pay the costs of loading and unloading such equipment.

(c) The cost of transporting equipment in low bed trailers shall not exceed the hourly rates charged by established haulers.

(d) The rental period shall begin at the time the equipment is unloaded at the site of the extra work, shall include each day that the equipment is at the site of the extra work, excluding Saturdays, Sundays and legal holidays unless the extra work is performed on such days, and shall terminate at the end of the day on which the Engineer directs the Contractor to discontinue the use of such equipment.

(e) Should the Contractor desire the return of the equipment to a location other than its original location, the State will pay the cost of transportation by the above provisions, provided such payment shall not exceed the cost of moving the equipment to the work.

(f) Payment for transporting and loading and unloading equipment as above provided will not be made if the equipment is used on the work in any other way than upon extra work paid for on a force account basis.

Material wasted or disposed of in a manner not called for under the contract, material not unloaded from the transporting vehicle, material placed outside of the limits indicated or given on the plans, or material remaining on hand after completion of the work will not be paid for except as otherwise provided.

**109.02 Scope of Payment.** Unless otherwise provided under "Basis of Payment," payments will be made for the actual quantities of contract items performed according to the plans and specifications, and if, upon completion of the construction, these actual quantities show either an increase or decrease from the quantities given in the proposal, the contract unit prices will still prevail, except as provided in Subsection 104.02.

Except as provided in 107.16, accept the compensation, as herein provided, in full payment for the following:

(a) The work complete, including all supervision, labor, material, tools, equipment and incidentals necessary for all work contemplated and embraced under the contract;

(b) Any loss or damage due to the nature of the work, the action of the elements, strikes or lockouts;

(c) Accidents to employees or the public, or both;

(d) Unforeseen difficulties or obstructions which may arise or be encountered during the prosecution of the work;

(e) All risks whatsoever connected with the work under contract until it is accepted;

(f) All expenses incurred by or in consequence of, the suspension or discontinuance of the prosecution of the work as herein specified, and in completing the work and the whole thereof, including the carrying out of all the requirements of these "general requirements and covenants" in an acceptable manner according to the plans and specifications.

If the "Basis of Payment" clause in the specifications relating to any unit price in the proposal requires that the said unit price cover and be considered compensation for certain work or material essential to the item, this same work or material will not be measured or paid for under any other pay item except as provided for in Subsection 104.04.

Any partial payment or payment of any retained percentage, except by and under the approved final progress payment and voucher, in no way shall affect the obligation to repair or renew any defective parts of the construction or to be responsible for all damages due to such defects.

Those Subsections containing pay items of bituminous materials are subject to the following requirements:

It is agreed by the parties to the contract that (a) in case the bituminous material does not conform to the requirements set forth in Section 703, damage will be sustained by the Department, and that (b) it is extremely difficult to ascertain the actual damage which the Department will sustain; therefore, it is agreed the Contractor shall pay to the Department as liquidated damages or the Department, at its option, may deduct from any money due or to become due the Contractor from the Department an amount set forth in the following schedule:

| Number of Demerits From Section 703 | Liquidated Damage, $ per metric ton (ton) *** Cutback Asphalts, Emulsions, PG Grades (a) | PG Grades (b) |
|---|---|---|
| 1-2 | 12 (10) | 22 (20) |
| 3-5 | 22 (20) | 44 (40) |
| 6-9 | 34 (30) | 66 (60) |
| 10-14 | 56 (50) | 110 (100) |
| 15-20 | 110 (100) | 220 (200) |
| 21-30 * | 75% of the cost of the asphalt product ** | |
| 31-40 * | 100% of the cost of the asphalt product ** | |
| 41* or more | Value and deduct to be determined | |

(a) Performance Graded Asphalts 58-28, 64-16, 64-22, and 70-16.
(b) Performance Graded Asphalts 64-28NV, 64-28NVTR, 76-22NV, and 76-22NVTR.

* Remove and replace material shown by test to have 21 or more demerits. At the option of the Engineer, material having 21 or more demerits may be left in place; if such material remains in place, the demerits specified above shall be assessed as liquidated damages for said material. Material removed will not be paid for and the removal thereof will be at the Contractor's expense.

** Cost of the asphalt cement will be based on the prices established under Subsection 402.05.01. Cost of the cutback asphalt or emulsified asphalt will be based on the Engineer's Estimate or the Contractors bid, whichever is greater, per metric ton (ton) of the asphalt product. When a bid item is not provided for cutback asphalt or emulsified asphalt, the cost of the asphalt product will be specified in the Special Provisions.

*** Liquidated damages for emulsified asphalts will be assessed per the diluted tonnage used. When a bid item is not provided for the bituminous material, the liquidated damages will be assessed on the tonnage calculated from the theoretical application rate or the Job Mix Formula.

Those Subsections containing pay items of Type 2, Type 2C, or Type 3 plantmix products are subject to the following requirements:

It is agreed by the parties to the contract that (a) in case the plantmix product does not conform to the Indirect Tensile Strength requirements set forth in Section 401, damage will be sustained by the Department, and that (b) it is extremely difficult to ascertain the actual damage which the Department will sustain; therefore, it is agreed the Contractor will pay to the Department as liquidated damages or the Department, at its option, may deduct from any money due or to become due the Contractor from the Department, $0.80 per metric ton ($0.72 per ton) per demerit for each metric ton (ton) of plantmix product placed. Remove and replace material shown by tests to have 21 or more demerits. Material removed will not be paid for and removal thereof will be at the Contractor's expense. At the option of the Engineer, material having 21 or more demerits may be left in place. If material having 21 or more demerits is allowed to remain in place, liquidated damages will be determined by the Department.

**109.03 Force Account Work.** On all force account work, submit the plan of work to be followed, the equipment to be used, and the amount and class of labor to be employed for review. Do not begin Force Account Work until receiving approval in writing.

Work specified and performed on a force account basis will be paid for as follows:

(a) Labor. The cost of labor will be paid for the workmen (including foremen when authorized by the Engineer), used in the actual and direct performance of the work. The cost of labor, whether the employer is the Contractor, subcontractor, or other forces, will be the sum of the following:

1. Actual Wages Plus Vacation Pay plus Zone Rates. The actual wages and zone rates paid, plus vacation pay, which shall not include any employer payments to, or on behalf of, workmen for health and welfare, pension, and similar purposes.

2. Labor Surcharge. To the actual wages, plus vacation pay, as defined above, will be added a labor surcharge, which shall constitute full compensation for all payments imposed by State and Federal laws. The labor surcharge will be calculated for each calendar year by the Department's Construction Division. The percentage may be obtained by contacting the Construction Division in the Department's General Headquarters, 1263 South Stewart Street, Carson City, Nevada 89712, phone (775) 888-7460.

3. Fringe Benefits. To the sum of paragraph 1. "Actual Wages Plus Vacation Pay plus Zone Rates," shall be added all other payments made to or on behalf of the workmen as required by collective bargaining agreements, or as otherwise provided in the Special Provisions.

   Provide a complete Fringe Benefit Statement (NDOT Form 052-062) for each job classification utilized on the contract.

4. Subsistence and Travel Allowance. Subsistence and travel allowance paid to such workmen as required by collective bargaining agreements.

To the total of the direct costs computed above, there will be added a markup of 25%.

(b) Materials. Materials accepted and used in the work will be paid for at the actual cost of such materials, to which cost shall be added an amount equal to 20% of the sum thereof.

(c) Equipment. For any machinery or special equipment, the use of which has been authorized by the Engineer, the Contractor will be paid for the use of equipment in the manner hereinafter specified, regardless of ownership and any rental or other agreement, if such may exist, for the use of such equipment entered into by the Contractor.

Rental rates will be determined as follows:

1. The base rates shall be those established by Penton Business Media, Inc. doing business as Equipment Watch thereto entitled "Enterprise Edition of Rental Blue Books" available from Equipment Watch, 1735 Technology Drive, Suite 410, San Jose, CA 95110-1313, phone (408) 467-6700 or at www.equipmentwatch.com.

The hourly rate to be paid shall be the monthly rate multiplied by an average regional adjustment factor of 1.05, divided by 176, multiplied by the appropriate rate adjustment factor, plus the estimated operating cost per hour shown therein.

2. Attachments (e.g. tractor with ripper and dozer or tractor with loader and backhoe) will be included in the hourly rental rate only when deemed essential to the work as determined by the Engineer. When multiple attachments are approved for use and are being used interchangeably, the attachment having the higher rental rate shall be the only one included for payment.

3. No direct payment will be made for necessary accessories (including replenishing blades, augers, teeth, hoses, bits, etc.) if not listed in the Rental Rate Blue Book.

4. No compensation will be allowed for shop tools having a daily rental rate of less than $10 as set forth in Section 18 of the Rental Rate Blue Book.

5. Equipment obtained through a third party rental agreement may be paid by the rate established by invoice plus a markup of 10% will be added thereto. Rental rate shall be comparable to other rental rates in the area. When the invoice specifies that the rental rate does not include fuel, lubricants, repairs and servicing, the Rental Rate Blue Book hourly operating cost for each hour the equipment is operated will be added.

A copy of the “Rental Rate Blue Book for Construction Equipment” is available for inspection by interested parties at the office of the Resident Engineer and in the Headquarters Construction Division Office in Carson City. Additionally, a copy of the “Rental Rate Blue Book for Older Construction Equipment” is available for inspection in the Headquarters Construction Division Office.

Interested parties desiring to purchase these publications should direct their inquiries directly to Equipment Watch at the address stated above.

If ordered to use equipment not listed in the aformentioned publications, a suitable rental rate for such equipment will be established. Furnish any cost data which might assist in the establishment of such rental rate.

Except as provided in Subsection 109.01, payment will be made for the actual time that such equipment is in operation on the work, to which rental sum 20% shall be added.

Authorized standby time for idle equipment will be paid for at 50% of the “monthly rate multiplied by an average regional adjustment factor of 1.05, divided by 176, multiplied by the appropriate rate adjustment factor,” rounded to the nearest $0.10. No operating cost, markup, overhead or profit will be added.

The rental rates paid as above provided shall include the cost of fuel, oil, lubrication, supplies, small tools, necessary attachments, repairs and maintenance of any kind, depreciation, storage, insurance and all incidentals.

If performing force account work, supply a complete Force Account Equipment Listing (NDOT Form 040-033) for each piece of equipment utilized.

(d) Subcontracted Work. Payment for subcontracted work may be made at the actual cost as evidenced by copies of invoices from the subcontractor performing the work. An additional 5% compensation will be paid on subcontracted work evidenced by invoice for administrative costs and profit.

When payment for subcontracted work is made under paragraphs (a), (b), and (c) above, reach agreement with subcontractor as to the distribution of the payment made. No additional payment will be made by reason that the work is performed by a subcontractor.

(e) Bond Costs. An additional 1% of the total labor, material, equipment and subcontracted compensation will be paid for increase in bond cost due to the force account work.

No additional allowance will be made for general superintendents, the use of small tools or other costs for which no specified allowance is herein provided.

At the end of each day the Contractor's representative and the Engineer shall compare records of the cost of the work to be done as ordered on a force account basis.

No payment will be made for labor performed on force account work until furnishing certified copies of payrolls covering that period when the force account work was performed. The payrolls shall indicate name, classification, dates, daily hours and hourly rate for each workman.

Furnish copies of the suppliers extended invoices, including transportation charges. However, if materials used on the force account work are not specifically purchased for such work, but are taken from the Contractor's stock, then in lieu of the invoices, furnish an affidavit certifying that such materials were taken from stock, that the quantity claimed was actually used, and that the price and transportation claimed represent the actual cost.

**109.04 Asphalt Escalation.** The use of the price adjustment provisions as developed and implemented herein are intended to minimize the cost effects of price uncertainty to the Contractor and the Department for "Asphalt Cement" used in the construction of the contract. The price adjustment provisions are not intended to serve as a guarantee for full compensation for "Asphalt Cement" price fluctuations but are intended to be a sharing, by the Department, in a portion of the Contractor's risk which could result from potentially volatile price fluctuations that might occur throughout the duration of the contract.

The price adjustment provisions do not serve to relieve the Contractor of risks associated with fluctuation in prices beyond the amount adjusted by the provisions. This adjustment will be full compensation for any and all price fluctuations, including but not limited to taxes, transportation, and delays.

The price adjustment provisions are only applicable to "Asphalt Cement;" they are not applicable to cutback asphalt or emulsified asphalt. The term "Asphalt Cement" as used herein is applicable to PG grades as specified in Subsection 703.03.02.

The progress payment will be adjusted upward or downward, as calculated by the "Total Bi-Weekly Adjustment." These adjustments will be determined by the Department and will be based on selling prices for asphalt cement in the Poten & Partners Asphalt Weekly Monitor report. The sources used by the Department to determine the asphalt cement price at any given time will be the selling prices for Utah/Idaho/Nevada for non-modified paving grades and the California paving grades. The average of the high and low selling price for each of the following areas will be used: Utah - Salt Lake City area; Idaho - Boise area, Eastern markets, Northern markets [includes E.WA]; Nevada - Las Vegas area, Reno area; California - San Francisco area, Los Angeles area, Bakersfield area. Each of these nine average area prices is then used to calculate the weekly average price; the weekly average price is used to calculate the "Basic Materials Index." The adjustment will be made by comparing a "Basic Materials Index" to a "Bi-Weekly Materials Adjustment Index." The method for making this comparison is described in the following paragraphs:

(a) A "Basic Materials Index" will be determined by the Department on a weekly basis. The "Basic Materials Index" in effect for the week a contract bid opening occurs will be the "Basic Materials Index" for that contract.

The "Basic Materials Index" will be arrived at by averaging the Monday posting of the current week and the Monday posting of the three previous weeks.

The "Basic Material Index" price for "Asphalt Cement" will be available on an informational basis to interested parties but said prices will not be available prior to the first regular business day of the week of the bid opening. The price may be obtained by contacting the Department's Construction Division.

(b) During the time that the "Asphalt Cement" is used on this contract, the Department will maintain selling prices in $/English ton (short ton) for asphalt cement to be used to obtain a "Bi-Weekly Materials Adjustment Index." The "Bi-Weekly Materials Adjustment Index" will be arrived at by averaging the Monday posting of the current week and the Monday posting of the three previous weeks and will be compared with the "Basic Materials Index" price to determine a "Bi-Weekly Material Price Adjustment."

(c) The adjustment for said "Asphalt Cement" will be subject to increase or decrease in accordance with the following provision for "Asphalt Cement" price fluctuations exceeding 10%. The adjustment will be determined in accordance with the following formula for "Asphalt Cement" used during the progress payment:

Total Bi-Weekly Adjustment = AQ

For an increase in the Bi-Weekly Materials Adjustment Index exceeding 10% of the Basic Materials Index:

$$A = [Bp — Bi (1.10)] F$$

For a decrease in the Bi-Weekly Materials Adjustment Index exceeding 10% of the Basic Materials Index:

$$A = [Bi (0.90) — Bp] F$$

Where:

A = "Bi-Weekly Material Price Adjustment" in dollars per metric ton (ton) of "Asphalt Cement" rounded to the nearest dollar.

Bi = "Basic Materials Index" for the week in which the bid opening for the contract occurred (US $/short ton). This is calculated as noted in paragraph (a) above.

Bp = "The Bi-Weekly Materials Adjustment Index" (US $/short ton) calculated for the progress payment period. This is calculated as noted in paragraph (b) above.

F = 1.102311 = Factor to convert $/short ton to $/metric ton (1.00 to remain $/short tons).

Q = Quantity in metric tons (tons) of "Asphalt Cement" calculated from the amount of plantmix paid for during the progress payment period. The quantity, in metric tons (tons), of "Asphalt Cement" will be calculated using the approved mix design and the following formula:

$$Q = \frac{\text{Wet tons used x \% Asphalt / 100}}{\text{[1 + (\% Asphalt + \% Mineral Filler) / 100]}}$$

(d) The adjustment in compensation will also be subject to the following:

1. The compensation adjustments provided herein, will be shown separately on the progress payment. The Contractor shall be liable to the State for decreased compensation adjustments and the Department may deduct the amount thereof from any monies due or that may become due the Contractor.

2. The Department reserves the right to cancel the contract whenever the "Bi-Weekly Materials Adjustment Index" exceeds the "Basic Materials Index" by 75%. The contract may be canceled in part or in whole by the Department. If the Department elects to cancel the contract, in part or in whole, price adjustments will not be allowed for other than major bid items. Adjustments to major bid items will be in accordance with Subsection 104.02.

**109.05 Fuel Escalation.** The Fuel Escalation Clause, as described herein, may be enacted when requested by the Contractor or deemed necessary by the Department. Enactment of the Fuel Escalation Clause will only be considered when the increase or decrease of the "Contract Price" for fuel as defined herein exceeds 25%.

The use of the price adjustment provisions developed for the Fuel Escalation Clause are intended to minimize the cost effects of price uncertainty to the Contractor and the Department, for fuel used in the construction of this contract. The price adjustment provisions are not intended to compensate the Contractor for what would be considered normal day-to-day fluctuations or seasonal changes. The price adjustment provisions are not intended to serve as a guarantee for full compensation for fuel price fluctuations but are intended to provide for a sharing, by the Department, in a portion of the Contractor's risk which could result from unusual price fluctuations. The price adjustment provisions do not serve to relieve the Contractor of risks associated with fluctuation in prices beyond the amount adjusted by the provisions.

If the Fuel Escalation Clause is activated, the clause will apply from the period of time the unusual price for fuel began, until the end of the contract.

**Fuel Escalation Clause**

Contract fuel costs will be adjusted upward or downward on a bi-weekly basis. To accomplish this adjustment the Department will determine, for each contract, a "Fuel Factor Percentage" that represents an estimated percent of fuel cost by type of construction. The "Fuel Factor Percentage" will be applied to each bi-weekly progress payment balance due (excluding payments for stockpiled materials) to determine a "Bi-weekly Fuel Cost."

The bi-weekly fuel adjustment will be calculated by comparing a "Contract Price" to an "Adjustment Price" to determine a percent of increase or decrease. The adjustment will be determined by the Department using the average diesel (No. 2 fuel oil) price postings for Reno and Las Vegas as provided by Oil Price Information Services. The method for calculating the "Bi-weekly Fuel Adjustment" will be as described in the following paragraphs:

(a) Fuel Factor Percentage (Ffp). The “Fuel Factor Percentage” (Ffp) will be an estimated fuel factor as a percentage of cost by type of construction as determined by the Department. The “Fuel Factor Percentage” will be specified in the Special Provisions.

(b) Bi-Weekly Fuel Cost (Bfc). The “Bi-Weekly Fuel Cost” (Bfc) will be the contract bi-weekly progress payment balance due (excluding payments for stockpiled materials) multiplied by the “Fuel Factor Percentage.”

(c) Base Price (Bp). The “Base Price” (Bp) for fuel will be determined weekly using the prices posted on Monday of each week.

(d) Contract Price (Cp). The “Contract Price” (Cp) for fuel will be established for the week during which the bid opening is held. The “Contract Price” will be determined using the “Base Price” of fuel for the week of the bid opening averaged with the “Base Price” of fuel recorded for the previous three weeks.

(e) Adjustment Price (Ap). The “Adjustment Price” (Ap) will be the average of the “Base Prices” recorded during the bi-weekly progress payment period.

(f) Compensation Formula. The compensation payable as part of each bi-weekly progress payment will be subject to increase or decrease in accordance with the following provisions for fuel price fluctuations exceeding 10%. The bi-weekly fuel adjustment will be determined in accordance with the following formula:

For an increase in fuel adjustment prices that exceed 10% of the “Contract Price” (Cp):

$$A = [(Ap/Cp) - 1.10]\ Bfc$$

For a decrease in fuel adjustment prices that exceed 10% of the "Contract Price" (Cp):

$$A = [0.90 - (Ap/Cp)]\ Bfc$$

Where:

A = Bi-weekly fuel adjustment in dollars rounded to the nearest dollar.
Ap = "Adjustment Price"
Cp = "Contract Price"
Bfc = "Bi-Weekly Fuel Cost"

(g) Compensation Adjustment. The adjustment in compensation for fuel shall also be subject to the following:

1. Payment of compensation provided herein will be made as part of the progress payment. The Contractor shall be liable to the state for decreased compensation adjustments and the Department may deduct the amount thereof from any monies due or that may become due the Contractor.

2. The Department reserves the right to cancel the contract whenever the "Adjusted Price" exceeds the "Contract Price" by 75%. The contract may be canceled in part or in whole by the Department. If the Department elects to cancel the contract, in part or in whole, price adjustments shall not be allowed for other than major bid items. Adjustments to major bid items shall be in accordance with Subsection 104.02.

**109.06 Partial Payment.** Progress payments will be made once each month as the work satisfactorily progresses. The progress payments will be based upon material in place, or on the job site and invoiced, and labor expended thereon. The total amount of the partial payment ascertained as allowable for payment will be paid each month until such time as a total of 85% of the contract price has been paid. The contract price will be adjusted upward or downward according to approved changes throughout the life of the contract. Once 85% of the adjusted contract price has been paid, the Department may withhold retention in the amount of 5% of said adjusted contract price or $50,000, whichever is less, until the entire contract is completed satisfactorily and accepted by the Director. If the work in progress is being performed on a satisfactory basis, the Director may reduce the percentage retained if he finds that sufficient reasons exist for additional payment and has obtained written approval from every surety furnishing bonds for the work. Any remaining money must be retained until the entire contract is completed satisfactorily and accepted by the Director.

Retention on Federal-Aid projects will be in accordance with 49 CFR 26.29(b)(2).

Control of retent funds under the contract:

Contract retent funds will be deposited with the State Treasurer in a Contract Retent Holding Account, identified by the contract number. The retent will be invested by the State Treasurer and interest earned on the balance will be credited to the retent account.

If a Contractor wishes the retent funds to be placed in a bank designated by him, pursuant to NRS 408.383, he must notify the Department in writing at the preconstruction conference. The Contractor must use a bank in the State of Nevada that meets the State Treasurer's collateralization requirements as set forth in NRS 356.020. Upon receiving the Contractor's choice of a bank to be used, the Department will submit the request to the State Treasurer for a determination that the bank meets their collateralization requirements. If the bank does not meet the requirements, the Contractor will be required to select a bank that does. The funds will be deposited into a time certificate of deposit or a money market account identified as "Nevada Department of Transportation Retent Funds for Contract No. * ." (* Contract number as assigned to each contract).

A Contractor may substitute securities as specified in NRS 408.383(5) of a market value at least equal in value to the amount of the retent and receive payment of the retent.

The Department will remain in control of the retent balance, including substituted securities, and the interest earned thereon, until final acceptance of the project and all certificates, guarantees, releases, affidavits and all other documentation required in the general provisions are received. Upon final acceptance, the retent and accrued interest thereon will be released to the Contractor. At the time of release of the contract retent principal, interest earned through the end of the previous calendar quarter will also be paid. Interest earned in the final quarter will be paid within 30 days after the end of the final quarter.

The interest paid to the Contractor is for the Contractor's benefit and is income to the Contractor for income tax purposes. If part of the retent is to be returned to the Department, the interest earned will likewise be prorated between the amount going to the Contractor and the amount being returned to the Department.

Pay administrative charges, if any, in connection with a requested deposit of the retent or a deposit by the Contractor of securities as provided by NRS 408.383, out of the interest accruing on the deposit or on the securities deposited.

The above deposit will be closed out and forwarded when the contract is accepted and determination made that the contract should be finalized and final payment made.

No payments will be made when the work is not satisfactorily proceeding according to the provisions of the contract.

Do not construe any progress payment to be an acceptance of any defective work, improper materials, or perishable materials that exceed the manufacturer's date of expiration prior to application.

Be responsible for any material that has been included in the progress payment.

The cost of materials conforming to the plans and specifications ("materials" being those which are required to be contained and incorporated in a finished contract bid item) and not at the time incorporated in the work, may also be included in the payment. In no case shall the amount paid exceed the amount bid for a particular bid item.

Partial payment will be made on manufactured materials which have been purchased and stockpiled for use on the project provided said materials are stockpiled within boundaries of the State of Nevada and subject to the following limitations:

(a) Stockpiled separate and apart from materials that are not to be used on this contract.

(b) Tagged or marked in such a manner that they are easily identified as materials for this contract.

(c) Kept safe from theft and vandalism.

(d) Allowed access to during normal working hours for periodic inspections by representatives of the State.

(e) Removed and utilized on this contract only.

(f) Stockpile materials subject to expiration dates according to the manufacturer's recommendations. Provide all applicable expiration dates for perishable materials.

Partial payment will also be made for stockpiled materials for Item No. 506 0100, "Structural Steel," stockpiled either within or outside the State of Nevada at the supplier's or Contractor's storage site. Partial payments for structural steel shall be subject to the preceding conditions in paragraphs (a) through (e) and in addition thereto, the following conditions in paragraphs (a) through (c):

(a) Roll steel plates to the proper dimensions for a particular girder.

(b) Provide invoices for labor and materials with the request for partial payment.

(c) All stockpiled plates shall be checked and verified against invoices by the on-site State inspector.

Partial payments will be made on "Class * ..... Concrete (Major)" and "Class * ..... Concrete, Modified (Major)," for falsework, forming, and for labor and materials involved, up to but not to exceed 70% of the plan quantity for the concrete item being formed. Up to 35% may be allowed of the plan quantity for the applicable concrete item as the falsework or earth shoring progresses. Also up to an additional 35% may be allowed as the deck forming progresses.
*(Class(es) to be as indicated in the proposal.)

In cases where there is minimal or no falsework, up to 70% may be allowed of the applicable major concrete item as the forming progresses.

Partial payments may be made on "local materials" meeting the requirements hereinafter outlined:

(a) Stockpile materials on or in the vicinity of the proper project, (generally on land adjacent to the project).

(b) Store materials in an approved manner in areas where damage from flood waters is not likely to occur. If at any time stored materials are lost or become damaged by floods or in any other manner, repair and replace such damaged materials. If payment has been made before such damage, the amount so allowed, or a proportionate part thereof, will be deducted from the next progress payment and withheld until satisfactory repairs or replacements have been made.

(c) Partial payments will be made only on materials that conform to plans and specifications (not to be construed as final acceptance). The quantities will be determined by volume measurement and converted to tons if the contract unit price of the item is in tons. In the case of "Portland cement concrete pavement," the unit price will be converted to square meter per metric ton (square yards per ton). However, partial payments shall not exceed the actual cost to provide the material.

(d) No payment will be made on any commercial stockpile or on any stockpile from which materials are being used for any purpose whatsoever other than incorporation into the project.

(e) Stockpile payment will be made at the contract unit price for the percentage of material allowed. The quantity in stockpile, or windrow, to be considered shall not exceed that required for the project.

(f) Schedule of Payments.

1. Not more than 40% of the unit bid price of Class A and Class B aggregate base courses and shouldering material in the stockpile may be allowed. Not more than 85% of the quantity of cement treated base roadmix in the processed windrow on the roadway may be allowed.

2. Not more than 30% of the unit bid price of cement treated base aggregate (roadmix or plantmix) in the stockpile may be allowed. Not more than 85% of the quantity of cement treated base roadmix in the processed windrow on the roadway (before adding cement) may be allowed.

3. Not more than $10.00 per metric ton ($9.00 per ton) for plantmix surface or open-graded surface aggregate in the stockpile may be allowed. When 40% of the unit bid price is less than $10.00 per metric ton ($9.00 per ton), not more than 40% of the unit bid price for plantmix surface or opengraded surface aggregate in the stockpile may be allowed.

4. Not more than 85% of the unit bid price of roadmix bituminous surface aggregate in the processed windrow on the roadway (before adding bituminous material) may be allowed.

5. Not more than 40% of the unit bid price of screenings in the stockpile may be allowed.

6. Not more than 85% of the unit bid price of selected material base conforming to all the requirements, in windrow may be allowed.

7. Not more than 20% of the unit bid price of Portland cement concrete pavement aggregates in the stockpile may be allowed. The stockpiled quantity shall be converted to square meters (square yards) of "Portland cement concrete pavement" for pay purposes.

8. Not more than 40% of the unit bid price of graffiti coating may be allowed once the coating has been stockpiled and expiration dates of the product have been provided.

9. Not more than 25% of the unit bid price of living or perishable plant material may be allowed once the plants are delivered to the project.

If materials are not specifically purchased for the work, but are taken from the Contractor's stock, then in lieu of invoices, submit statements accompanied by an affidavit, certifying such materials were taken from stock and the price and transportation claimed represent the actual cost.

Unless otherwise specified, all material and work covered by partial payments shall thereupon become the property of the State, but do not construe this provision as relieving the responsibility for all materials and work upon which payments have been made or the restoration of any damaged work, or as a waiver of the right of the Department to require the fulfillment of all terms of the contract.

No payment, partial or otherwise, will be made for the item of "watering." Consider full compensation for developing and maintaining an adequate water supply included in other items of work.

No stockpile payments will be made on rent traffic control devices.

When construction signs and rent traffic control devices are listed as separate items according to Section 625, partial payments will be made as hereinafter outlined:

(a) Construction Signs. When construction signs are placed on the project, according to the plans and specifications, 50% of the contract price per square meter (square foot) of acceptable signs in place will be paid for on the next progress payment after placing. The remaining percent will be prorated according to job progress. However, if signing becomes inadequate for job requirements, an adjustment downward will be made on the first progress payment following such inadequacy.

(b) Rent Traffic Control Devices. When traffic control devices are placed on the project according to the plans and specifications, 50% of the contract bid price per linear meter (linear foot) or per each, as the case may be, of the traffic control devices thus in use will be paid for on the next progress payment after placing. The remaining percent will be prorated according to job progress. However, if traffic control devices become inadequate for job requirements, an adjustment downward will be made on the first progress payment following such inadequacy.

When the proposal contains the item "Rent Traffic Control Devices (Lump Sum)" according to Section 625, partial payments will be made as hereinafter outlined:

The Engineer will determine the reasonable payment percentage of the Rent Traffic Control Devices (Lump Sum) for each payment cycle. The payment percentage will be based on the progress of the work and the quantity of traffic control devices placed on the project according to the approved traffic control plans. The amount paid on the next progress payment will be 50% of the amount determined. The remaining percentage will be prorated according to job progress. However, if traffic control devices become inadequate for job requirements, an adjustment downward will be made on the first progress payment following such inadequacy.

A maximum amount of 10% of the original contract amount will be paid during the progress of the work. Upon completion of all work on the project, payment of any amount bid for Rent Traffic Control Devices (Lump Sum) in excess of 10% of the original contract amount will be paid.

Partial payments will be made on the items of fence, guardrail, bridge rail, mobilization, signal systems and/or highway lighting systems, cattle guards, and trenching for irrigation systems as hereinafter noted provided that materials and equipment are satisfactorily supplied:

(a) Fence. When fencing material is stored on the project, invoice prices may be paid as outlined herein. When the fence posts have been placed, 50% of the partially completed fence will be eligible for payment at the contract unit bid price. The remaining 50% will be eligible for payment when the item is complete.

The cost of wire and posts conforming to the plans and specifications which are required to be contained and incorporated in a finished contract bid item delivered to the project and not at the time incorporated in the work, may be included in the partial payment.

(b) Guardrail and Bridge Rail. Guardrail and bridge rail materials stored on the project according to this Subsection may be included for stockpile payment.

When posts for guardrail or reconstruct guardrail are complete in place, 50% of the partially completed guardrail will be eligible for payment at the contract unit bid price. The remaining portion of the contract unit bid price will be eligible for payment when the item is complete.

(c) Mobilization. Partial payments will be made by the following schedule:

1. When 5% of the original contract amount is earned from other than mobilization, 50% of the amount bid for mobilization, or 5% of the original contract amount, whichever is less, will be paid.

2. When 10% of the original contract amount is earned from other than mobilization, 100% of the amount bid for mobilization, or 10% of the original contract amount, whichever is less, will be paid.

3. Upon completion of all work on the project, payment of any amount bid for mobilization in excess of 10% of the original contract amount, will be paid.

(d) Signal Systems and/or Highway Lighting Systems. The cost of materials for luminaries, poles and mast arms, controllers and cabinets, signal heads, and detector units, conforming to the plans and specifications ("materials" being those which are required to be contained and incorporated in a finished contract bid item) delivered to the project and not at the time incorporated in the work, may also be included for stockpile payment. Other items will not be included for partial payment until incorporated in the work.

(e) Cattle Guards. The first progress payment after the cattle guard has been completed, but the wings not yet installed, will show this item 90% complete. The remaining 10% shall be eligible for payment on the first progress payment after the wings have been installed.

(f) Trenching for Irrigation Systems. When trenches for irrigation pipe distribution lines have been excavated and the pipe has been placed but not backfilled, 50% of the partially completed irrigation pipe will be eligible for payment on the next progress payment at the contract unit price. Payment will be based on that length of the pipe partially complete. The remaining 50% will be eligible for payment on the first progress payment following complete installation of the pipe.

**109.07 Acceptance and Final Payment.** When the final inspection and final acceptance have been duly made as provided in Subsection 105.16, and subject to the terms of Subsection 108.09, the final progress payment of quantities of the various classes of work performed under the contract will be prepared. Examine such progress payment and give notification in writing of agreement or file a specific claim covering disputed quantities. Failure to give notification or file a claim within a period of 30 days after receipt of the progress payment shall constitute agreement to the quantities as set forth, and shall eliminate further claim against the Department, except as indicated in the final progress payment of quantities.

Final payment of the work will be withheld until all certificates, guaranties, releases, affidavits, and any other documentation required by these specifications have been furnished.

**109.08 Payments to Subcontractors.** Maintain records and documents of payments to subcontractors for 3 years following the final inspection and acceptance of the contract. These records must be available for inspection upon request by any authorized representative of NDOT or FHWA. This requirement also extends to any subcontractor.

Provide a monthly report of payments to each subcontractor on NDOT contracts on NDOT Form 052-060, Subcontractor Payment Form by the 15th day of each month. Monthly submission of Form 052-060 is considered as a necessary portion of the work; therefore, partial payments as set forth under Subsection 109.06 may not be forthcoming until this requirement is complied with.

The prime contractor shall pay each subcontractor for satisfactory performance of the subcontractor's contract no later than 15 days from the receipt of each payment the prime contractor receives from the NDOT. The prime contractor agrees further to return retainage payments to each subcontractor within 30 days after the subcontractor's work is satisfactorily completed in accordance with 49 CFR 26.29(b)(2). For the purposes of this Subsection, satisfactory completion is defined as the following conditions: (a) Satisfactory completion of the subcontractor's scope of work as described in the contract documents; (b) Receipt of payment for subcontractor's scope of work; (c) Release of claims from subcontractor's laborers, material and equipment suppliers, and lower tier subcontractors; (d) Payment, if applicable, of all union benefits or to employee trust accounts.

The NDOT will also review payments to DBE/SBE subcontractors to ensure that the actual amount paid to subcontractors is consistent with the dollar amounts stated in the schedule of DBE/SBE participation.

The NDOT will bring to the attention of the U.S. Department of Transportation (USDOT) any false, fraudulent, or dishonest conduct by the prime contractor in connection with the Federal Aid requirements and the DBE program, so that the USDOT can take the steps (e.g. referral to the Department of Justice for criminal prosecution, referral to the USDOT Inspector General, action under suspension and debarment or Program Fraud and Civil Penalties rules) provided in Subpart F of 49 CFR, Part 26.

The NDOT will consider action under their legal authorities, including responsibility determinations in future contracts, for any false, fraudulent, or dishonest conduct by the prime contractor in connection with the subcontractor information or payments.

# SECTION 110

## WAGES AND CONDITIONS OF EMPLOYMENT

**110.01 Description.** The provisions pertaining to wages and conditions of employment shall apply to all work performed (on the contract) by the Contractor with his own organization and with the assistance of workmen under his immediate superintendence, and to all work performed on the contract by subcontractors.

Minimum wage rates determined by the Labor Commissioner of the State of Nevada and by the Secretary of Labor, if applicable, are set forth in the contract documents. Do not pay wage rates less than the minimum wage rates.

Forfeit, as a penalty to the Department, the amount stipulated in NRS Chapter 338 when workmen are paid less than the minimum wage rate.

The laborers shall have access to the pertinent minimum wage schedules at all times. Provide and erect a weatherproof bulletin board at the job site and post all minimum wage schedules and other required information thereon. Construct the weatherproof bulletin board so that the material thereon is adequately protected from the elements.

It is a condition of the contract, and shall be made a condition of each subcontract entered into pursuant to the contract, that the Contractor and any subcontractor shall not require any laborer or mechanic employed in performance of the contract to work in surroundings or under working conditions which are unsanitary, hazardous, or dangerous to his health or safety as determined under construction safety and health standards (Title 29, Code of Federal Regulations, Part 1926—published in the Federal Register on December 16, 1972, and subsequent revisions) promulgated by the United States Secretary of Labor, according to Section 107 of the Contract Work Hours and Safety Standards Act, (83 Stat. 96).

The minimum wage rates apply to workmen working upon the “site of the work.” The term “site of the work” is defined as follows:

> The “site of the work” is defined as the physical place or places where work called for in the contract is performed by either the Contractor or the Contractor’s agents. Material sources controlled by the Department and staging areas set up to construct portions of the work are considered to be the “site of the work.” Not included in the “site of the work” are permanent home offices, batch plant establishments, fabrication plants, and tool yards of an employer whose locations and continuance in operation are determined without regard to the work. In addition, fabrication plants, batch plants, borrow pits, job headquarters, tool yards, or other like locations of a commercial supplier or materialman which are established by a supplier of materials for the project before opening of bids are not included in the “site of the work.”

The Contractor and subcontractors compliance with Title 29, subtitle A, 3.3, Code of Federal Regulations and NRS 338 will be required on this contract. These regulations require submittal of a tally of weekly payroll and statement of compliance with respect to each employee engaged in work on the project. Submit these payrolls and statement of compliance to the Nevada Department of Transportation and the State of Nevada Labor Commissioner.

Submit payrolls electronically via the internet into the Department’s contracted payroll tracking system. The system information and access fee will be listed in the Special Provisions. This requirement will apply to every lower-tier subcontractor and vendor required to provide certified payroll reports by NRS 338.010 to 338.090 inclusive. Upon issuance of the Notice to Proceed, the Department will provide the Contractor with the website addresses and a Login Identification and Password to access the payroll system.

**110.02 Laws Cited.** See the provisions and requirements of the following:

(a) Wages, Hours and Employment on Public Works—NRS Chapter 338.

(b) Nevada Industrial Insurance Act—NRS Chapter 616A. Furnish a certificate from the insurer as evidence of payment of all the premiums and percentages as required by the act, and furnish said certificate before any work is commenced.

(c) Unemployment Compensation Law—NRS Chapter 612.

(d) Highway Camp Sanitation—NRS 444.130, 444.200 and 444.210.

(e) Highways and Roads Law—NRS Chapter 408.

(f) Fair Labor Standards Act of 1938 (52 Stat. 1060).

(g) Work Hours Act of 1962.

(h) Any and all legislation, rules or regulations promulgated by the State of Nevada, or its agencies, covering any work performed by the Contractor.

(i) Fraudulent and Discriminatory Employment Practices—NRS Chapter 613.

**110.03 Training Program.** The on-the-job training program shall apply as set forth in the Training Special Provisions. Consider the Training Special Provisions as contained herein.

The number of trainees to be trained will be as indicated in the Training Special Provisions.

METHOD OF MEASUREMENT

**110.04 Measurement.** Training will be measured by the hour that trainees are employed on the contract.

BASIS OF PAYMENT

**110.05 Payment.** The accepted quantities of training, measured as specified above, will be paid for at the price per hour as specified in the Training Special Provisions and indicated in the Proposal. Payment will be full compensation for the work prescribed in this Section.

Payment will be made under:

| Pay Item | Pay Unit |
|---|---|
| Training | Hour |

# DIVISION II

# CONSTRUCTION DETAILS

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## SECTION 200

### CONSTRUCTION STAKEOUT

DESCRIPTION

**200.01.01 General.** This work consists of construction stakeout to be performed both by the Department and the Contractor.

Perform the complete stakeout of bridge structures, including the approach slabs and slope paving, and all stakeout necessary to construct bridge structures to completion in accordance with the plans and as directed.

The Department will perform all stakeout necessary for the construction of R.C.B.'s.

All other stakeout necessary to complete this project will be performed by the Department.

Certify that the personnel to perform stakeout work are experienced and fully capable of providing accurate results.

On major structures constructed with structural steel girders, obtain tenth point elevations on the erected unloaded girders and supply said elevations to the Engineer prior to installing the deck forms.

Furnish the Engineer copies of all field notes and calculations used to complete stakeout requirements.

Be responsible for the accuracy of the stakeout work performed.

Correct any errors in stakeout and related work involved performed at own expense.

METHOD OF MEASUREMENT

**200.04.01 Measurement.** Construction stakeout will not be measured for payment.

BASIS OF PAYMENT

**200.05.01 Payment.** There shall be no direct payment for construction stakeout and all work involved shall be considered included in the various contract bid items of work requiring construction stakeout.

# SECTION 201

## CLEARING AND GRUBBING

DESCRIPTION

**201.01.01 General.** This work consists of urban or rural clearing and grubbing and shall include one or both of the following categories:

(a) Removal and disposal of all vegetation and trash within construction limits.

(b) Removal and disposal of all natural or manmade objects and trash within the right of way limits of the project, except such objects as are designated to remain or be removed according to other sections of these specifications.

Do not injure or damage vegetation and objects designated to remain undisturbed.

CONSTRUCTION

**201.03.01 General.** Areas to be cleared, and all things that are to remain undisturbed will be designated.

**201.03.02 Areas to be Cleared.** Normally, clear and grub the area within construction limits.

**201.03.03 Clearing and Grubbing.** Clear and/or grub all surface objects and all trees, stumps, roots and other protruding obstructions, designated for removal.

If permitted, sound stumps that are cut off flush with ground level, or not more than 150 mm (6 in.) above the ground when flush with ground level is not possible, may be left outside of the construction limits of cut and embankment areas. In the area to be rounded at the top of backslopes, cut off stumps flush with or below the surface of the final slope line.

Fell trees toward the center of the area to be cleared. Where trees cannot be felled without danger to traffic or injury to other trees, structures or property, cut in sections from the top down.

Do not burn as a method of disposal.

Except in areas to be excavated, backfill stump holes and other holes from which obstructions are removed with suitable material. If within the roadway prism, compact the material according to Subsection 203.03.15.

Merchantable timber in the clearing area shall become the property of the Contractor.

Remove low hanging and unsound or unsightly branches as directed on trees and shrubs that are to remain in place. Trim branches of trees to give a clear height of 6 m (20 ft) above the roadbed surface. Trim according to good tree surgery practices. Paint cut or scarred surfaces of trees or shrubs selected for retention with an approved asphaltum based paint prepared especially for tree surgery.

Scalping shall include the removal of material such as brush, roots, sod, grass, residue of agricultural crops, sawdust and decayed vegetable matter from the surface of the ground.

Scalp areas where excavation or embankment is to be made, except that mowed sod need not be removed where embankment is a minimum of 1.25 m (4 ft).

Dispose of cleared and grubbed material according to Subsection 107.14.

**201.03.04 Rural Clearing.** Rural clearing consists of removing and disposing of all natural and man made objects that are not compatible with completion of the project unless otherwise provided.

**201.03.05 Urban Clearing.** Urban clearing consists of removing and disposing of all unsightly organic or man-made objects within right of way limits of the project. Extend this work to all areas within the environmentally cleared right of way whether or not the plans require work in such areas.

If permitted, certain items such as broken concrete or asphaltic paving material, may remain in place provided they are covered by a minimum of 1 m (3 ft) of embankment. The material to be removed shall include but not be limited to rocks, brush, other vegetation, buildings, appurtenances such as lighting and signing, foundations, concrete slabs, tanks, fences, and trash.

Grade the site to drain and blend with the natural ground. Eradicate all streets, foundations, and other unnecessary man-made objects.

## METHOD OF MEASUREMENT

**201.04.01 Measurement.** Urban or rural clearing, or clearing and grubbing will be measured by the lump sum, force account, or hectare (acre).

Removal of trees will be measured by the each including any necessary removal of their stumps. When trees are specified to be removed according to trunk diameter, the diameter will be measured at a height of 600 mm (24 in.) above ground line. Any growth less than 150 mm (6 in.) in diameter at that point shall be classified as brush and will not be included in the individual measurement of removal of trees. The diameter of trees with multiple trunks will be measured by the diameter encompassing all trunks.

Removal of stumps will be measured by the each.

When removal of individual items does not appear in the proposal, consider such work included in other items of work.

## BASIS OF PAYMENT

**201.05.01 Payment.** The accepted quantities, measured as provided above, will be paid for at the contract price per unit of measurement for the pay items listed below that are shown in the proposal. Payment will be full compensation for the work prescribed in this Section.

Payment will be made under:

| Pay Item | Pay Unit |
|---|---|
| Urban Clearing | Lump Sum, Force Account, or Hectare (Acre) |
| Rural Clearing | Lump Sum, Force Account, or Hectare (Acre) |
| Clearing and Grubbing | Lump Sum, Force Account, or Hectare (Acre) |
| Remove Trees (size) | Each |
| Remove Stumps | Each |

# SECTION 202

## REMOVAL OF STRUCTURES AND OBSTRUCTIONS

### DESCRIPTION

**202.01.01 General.** This work consists of the removal, wholly or in part, and satisfactory disposal of all buildings, fences, guardrail, structures, pavements, culverts, curbs, sidewalks, pole bases, foundations, and any other obstructions which are not designated or permitted to remain, except for the obstructions to be removed and disposed of under other items in the contract.

This work also includes the salvaging of designated materials and backfilling the resulting trenches, holes, and pits.

### CONSTRUCTION

**202.03.01 General.** Raze, remove, and dispose of all buildings and foundations, fences, guardrail, structures, pavements, culverts, curbs, sidewalks, and other obstructions, any portions of which are on the right of way, except utilities and those for which other provisions have been made for removal.

Remove all designated salvageable material, without unnecessary damage, in readily transportable sections or pieces and stockpile at specified places within the project limits.

Destroy unusable perishable material. Nonperishable material may be disposed of according to Subsection 107.14.

Fill basements or cavities left by structure removal to the level of the surrounding ground and, if within the prism of construction, compact according to Subsections 203.03.14, 203.03.15, or 203.03.16.

**202.03.02 Removal.** Do not remove bridges, culverts, and other drainage structures in use by traffic until satisfactory arrangements have been made to accommodate traffic.

Complete all removal operations which might endanger the new construction before the construction of the new work. Do not use equipment or devices which might damage structures, facilities, or properties which are to be preserved and retained.

Remove the substructures of existing structures down to the natural stream bottom and remove those parts outside of the stream down to 0.3 m (1 ft) below natural ground surface. Where such portions of existing structures lie wholly or in part within the limits for a new structure, remove those portions as necessary to accommodate the construction of the proposed structure.

Limit the mass of pneumatic hammers to a maximum of 16 kg (35 lb) for removing concrete as part of expansion joint removal.

In removing concrete pavement, curb, curb and gutter, sidewalk, and similar structures, where portions of the existing structures are to be left in the surface of the finished work, remove the structure to an existing joint, or cut and chip to a true line with a face perpendicular to the surface of the existing structure. Make sufficient removal to provide for proper grades and connections in the new work.

In removing bituminous surface, saw cut or use other approved methods to cut a true line, leaving a clean vertical cut along any adjacent bituminous surface to remain in place.

Remove bituminous surface from existing bridge decks by approved methods and equipment which will not damage the existing concrete decks.

In removing manholes, catch basins, and inlets, rebuild any live sewer connections to them and properly reconnect and satisfactory maintain a by-pass service. Do not remove manholes, inlets, and pipe until pipe to remain has been cut and plugged or modifications have been made to accommodate flows.

Remove painted traffic lines on surfaces to remain after the projects completion by hydroblasting. Perform removals on all other surfaces by approved methods. Exercise care to prevent damage to pavement surfaces, joint material and bridge joints.

Remove temporary pavement striping immediately after traffic has been re-routed and the temporary pavement striping is no longer required.

For removal of bridges, submit 5 sets of complete demolition plans, as working drawings, according to Subsection 105.02. Include all methods and equipment outlining the details of removal operations.

When bridges are to be removed over UPRR right of way, develop a demolition plan in accordance with "GUIDELINES FOR PREPARATION OF A BRIDGE DEMOLITION AND REMOVAL PLAN FOR STRUCTURES OVER RAILROAD" published by the Union Pacific Railroad. Copies may be obtained from the Railroad contact listed in Subsection 107.08. Submit 6 copies of the demolition plan, as working drawings, according to Subsection 105.02. Such plans shall be stamped by an engineer who is registered as a Civil Engineer in the State of Nevada.

**202.03.03 Removal of Bituminous Surface by Cold Milling.** Remove bituminous pavement by the cold milling process, using a machine designed to remove, profile, and texture the remaining surface of the pavement in one operation.

The milling machine shall consist of a rotating powered mandrel drum studded with conical tungsten carbide tipped bits and shall produce a satisfactory reasonable smooth textured surface, and shall be equipped with an effective means for controlling dust and other particulate matter created by the cutting action.

Use a machine capable of accurately establishing profile grades, within plus or minus 6 mm (0.25 in.), by referencing from the existing pavement or concrete bridge decks or from an independent grade control and having a positive means for controlling cross slope elevations. When referencing from the existing pavement or concrete surface on bridge decks, use a 3 m (10 ft) minimum averaging ski. The use of the averaging ski may be discontinued, if approved, on concrete bridge decks.

The location and depth of removal of bituminous surface by cold milling shall be as indicated on the plans.

Increase milling depth at cross streets and curb ramps as directed.

Follow with the removal crew within 75 m (250 ft) of the milling machine. Broom the milled surface with a motorized pickup brooming device following immediately behind the removal crew.

Make the cuts vertical at longitudinal edges for the full depth of the milling. Clean the entire milled surface of all loose material before applying the tack coat.

Areas of stripping or delamination which are exposed or produced during the cold milling operation may need to be removed by an additional 50 mm (2 in.) maximum depth of cold milling as directed. These additional cold milling areas will be measured and paid for as "Remove Bituminous Surface (Miscellaneous Cold Milling)."

**202.03.04 Removing Composite Surface.** Removal of composite surface consists of the removal of all materials including bituminous or concrete surfaces, aggregate base, and subgrade to the limits necessary to accommodate the new base and surface.

After removal of composite surface, compact the bottom of the excavation to not less than 90% according to Subsection 203.03.15.

**202.03.05 Extensions.** Where existing culverts and bridges are to be extended or otherwise incorporated in the new work, remove only such part or parts of the existing structure as is necessary to provide a proper connection to the new work. Cut, shape, and trim the connecting edges to the required lines and grades without weakening or damaging the part of the structure to be retained. Do not damage reinforcing bars which are to be left in place so as to project into the new work as dowels or ties.

**202.03.06 Closing Culverts.** Close existing culverts within construction limits, the top of which are 1.5 m (5 ft) or more below finished roadway grade, unless otherwise noted on the plans. Remove the headwalls of such culverts, or any part of the structure that is within 1 m (3 ft) of the finished grade line. Completely fill the ends of the culvert with satisfactory soil for a distance of at least 0.6 m (2 ft), plus the height of the opening of the structure.

**202.03.07 Cleaning Culverts.** Clean and dispose of silt or debris from inside culvert pipes at the locations noted on the plans. Use approved methods and equipment to accomplish the cleaning of culvert pipes.

**202.03.08 Salvage.** When specified, remove gravel, roadmix, or plantmix surface suitable for reuse to the depth required and carefully salvage and place in compact stockpiles at approved locations. Exercise care to prevent contamination of stockpiled material. Scarify any remaining unsuitable material and incorporate in embankment as set forth in Section 203.

When specified, salvage, haul, and use the material produced by the cold milling of bituminous surface as shouldering material. Prepare shoulders and place and compact the cold milled material according to Subsections 307.03.01 and 307.03.02. Cold milled bituminous surface material to be used as shouldering material shall conform to the following gradation requirements:

| Sieve Size | Percent Passing by Mass |
|---|---|
| 75 mm (3 in.) | 100 |
| 50 mm (2 in.) | 95-100 |

Remove fences and gates designated for reuse in such a manner that so far as practicable all material can be salvaged. Carefully remove wire from the posts and roll in rolls of such size that can be conveniently handled. Remove posts by methods that will keep breakage to a minimum.

Remove guardrail, object markers, and guide posts designated for reuse in such a manner that so far as practicable all material can be salvaged. Remove bolts, supports, and other hardware from all rails, plates, and posts. Sort parts and store at the locations specified. Properly stack rails, plates, and posts. Stack or box miscellaneous hardware.

When specified for salvage, store structural steel removed from old structures in a neat and presentable manner on blocking and at locations suitable for loading. Store structures or portions thereof, which are specified for re-erection, in separate piles.

Remove all nails and bolts from timber or piling from structures designated to be salvaged and store in neat piles at locations suitable for loading.

Exercise care in handling, storage, and preservation of materials.

**202.03.09 Disposing of Materials.** Unless otherwise provided, use excavated material in backfilling excavations made in removing the structure, in constructing embankment, or otherwise dispose of in a satisfactory manner.

Dispose of any concrete or masonry which cannot be placed in embankments, in such a manner as to prevent damage to property or the creation of unsightly conditions. Do not place the material where it will obstruct any drainage course.

When concrete or masonry is placed in embankments, place according to Subsection 203.03.13.

Any material removed and not designated for salvage shall become the property of the Contractor and shall be removed from the project before completion thereof. See Subsection 107.14.

## METHOD OF MEASUREMENT

**202.04.01 Measurement.** Removal of structures and obstructions will be measured by the each, linear meter (linear foot), square meter (square yard) (square foot), cubic meter (cubic yard) (cubic foot), or lump sum. Removal by the linear meter (linear foot) and square meter (square yard) (square foot) will be measured before removal.

Removal of painted traffic line from all types of surfacing will be measured by the linear meter (linear foot) regardless of line width or pattern for the actual linear meters (linear foot) of line removed. Each line removed will be measured separately. Double solid and broken w/solid lines will be considered as one line. Gaps in broken and dotted lines will be included in the linear measurement.

Removal of bituminous surface by cold milling will be measured once, regardless of the number of passes necessary to obtain the depth specified on the plans and as approved.

Cleaning culvert pipe will be measured by the linear meter (linear foot). No additional compensation will be made for cleaning culverts of different sizes.

BASIS OF PAYMENT

**202.05.01 Payment.** The accepted quantities, measured as provided above, will be paid at the contract price per unit of measurement for the pay items listed below that are shown in the proposal. Payment will be full compensation for the work prescribed in this Section.

When the proposal does not include any pay item or an appropriate pay item for removal of any structure or obstruction as set forth in this Section, such work shall be performed and payment therefore will be considered as subsidiary to other items of work. No additional compensation will be allowed.

Payment will be made under:

| **Pay Item** | **Pay Unit** |
|---|---|
| Remove (*), or Removal of (*) | Linear Meter (Linear Foot), Kilometer (Mile), Square Meter (Square Yard) (Square Foot), Cubic Meter (Cubic Yard) (Cubic Foot), Each, Station, or Lump Sum |
| Clean Culvert Pipe | Linear Meter (Linear Foot) |

* Description as specified in the proposal.

# SECTION 203

## EXCAVATION AND EMBANKMENT

### DESCRIPTION

**203.01.01 General.** This work consists of excavating material, constructing embankments, and placing engineering fabrics. This includes furnishing, hauling, stockpiling, placing, disposing, sloping, shaping, compacting, and finishing earthen and rocky material. Perform work in close conformity with the alignment, grades, and cross sections shown on the plans or as established.

### MATERIALS

**203.02.01 General.** Material shall conform to the following Subsections and Section:

| | |
|---|---|
| Borrow | Subsection 704.03.12 |
| Selected Borrow | Subsection 704.03.13 |
| Engineering Fabrics | Section 731 |

**203.02.02 Roadway Excavation.** Roadway excavation consists of all excavation involved in grading and constructing the roadway and appurtenances, irrespective of the nature or type of material encountered. Exceptions are excavation designated as structure excavation, drainage excavation, and channel excavation when these items are provided as items of work under the contract. Dividing the project into construction stages shall not be construed as separate material classification.

**203.02.03 Drainage Excavation.** Drainage excavation includes all excavation in the construction of open ditches less than 3.6 m (12 ft) in bottom width, except ditches that are part of the roadway prism as shown on the plans. The nature or type of material encountered shall have no bearing on the classification of material.

**203.02.04 Channel Excavation.** Channel excavation includes all excavation in the construction of open ditches with a bottom width of 3.6 m (12 ft) or more with the exception of ditches that are part of the roadway prism as shown on the plans. The nature or type of material encountered shall have no bearing on the classification of material.

**203.02.05 Borrow.** Borrow consists of approved material required for the construction of embankments. Material obtained from excavation items is considered excavation only and not borrow. Borrow will not be classified according to type or character of material encountered in the borrow area unless otherwise required in the Special Provisions.

Do not use pea gravel as borrow. Pea gravel is typically a byproduct of aggregate crushing and/or screening operations. It is uniformly graded, normally having a nominal size of 9.5 mm (3/8 in.).

**203.02.06 Selected Borrow.** Selected borrow consists of approved material required for the construction of embankments.

Do not use pea gravel as selected borrow. Pea gravel is typically a byproduct of aggregate crushing and/or screening operations. It is uniformly graded, normally having a nominal size of 9.5 mm (3/8 in.).

### CONSTRUCTION

**203.03.01 Roadway.** Excavate to lines and grades as staked. Avoid removing or loosening any material outside the required slopes. Replace and compact any disturbed material to the required cross section.

Grade intersecting roads, approaches, and driveways as shown in the plans or as directed.

Begin at some definite point or points on the project, and carry forward in an approximately completed manner. Grade the roadway to full cross section width before placing base or surfacing of any type, unless otherwise specified.

Incorporate only suitable material into embankments. Dispose of unsuitable material.

**203.03.02 Unsuitable Material.** Unsuitable material shall be defined as mixtures of soils, organic matter or other material not suitable for embankment material regardless of moisture content. Excavate and dispose of unsuitable material, including material below the natural ground surface in embankment areas as directed.

Fill any resulting subexcavation with material suitable for the planned use. Place and compact such suitable material in layers as hereinafter specified under embankment.

Dispose of material outside the right of way according to Subsection 107.14.

**203.03.03 Blasting.** Remove any material outside the authorized cross section on the backslopes which may be shattered or loosened because of blasting. Compact or remove shattered or loosened material below the bottom limits of required excavation. Discontinue any method of blasting which leads to overshooting or is dangerous to the public or destructive to property or to natural features. See Subsection 107.10.

**203.03.04 Rock Cuts.** Do not break down, loosen, or otherwise damage supporting rock below the bottom limits of the required excavation.

Scale and dress the slope of all rock cuts to a safe, stable condition by removing all loose spalls and rock not firmly keyed to the rock slope. Remove overhanging rock which may be a hazard to public use of the roadway.

Construct slopes in solid rock excavation to the approximate neat lines as staked. No rock shall project or overhang more than 300 mm (12 in.) from the true slope.

**203.03.05 Overbreak.** Overbreak is that portion of material excavated, displaced or loosened outside and beyond the slopes or grade as staked or reestablished, regardless of the cause. Slides and slipouts as defined in Subsection 203.03.09, and that portion of rock subgrade as hereinafter set forth, shall not be considered overbreak. Remove all side slope overbreak and dispose of as surplus material according to Subsection 203.03.07.

Rock removed to a maximum depth of 150 mm (6 in.) below subgrade will be measured for payment as described in Subsection 203.04.01 (b).

**203.03.06 Slopes.** Trim excavation and embankment slopes, except in solid rock, to the lines as staked.

Round the top of cut slopes by excavating to blend the cut slopes with the adjacent natural terrain. Round the top of embankments. At the intersection of cuts and fills, adjust and warp slopes to blend into each other or into the natural ground surface without noticeable break.

Cut slopes will be staked for flattening and rounding in places where the material is other than solid rock. Rock formations such as shales, decomposed sandstone, and granite that can be readily excavated by means of hand tools, shall have the slopes flattened and rounded the same as earth slopes. A layer of earth overlying a rock cut shall be rounded above the rock the same as earth slopes.

Where the depth of cut or fill is insufficient to provide the full rounding required, proportionately adjust the distance for rounding.

Slope rounding and warping shall also apply to drainage ditches.

Adjust slope grading to protect standing timber, trees or other vegetation which should be preserved. Adjust by a gradual transition from the theoretical grading section required.

Construct slopes with a degree of smoothness that can be normally obtained by hand shovel operations.

**203.03.07 Surplus Material.** Use surplus excavated material to widen embankments uniformly, or to flatten slopes, or at other approved locations. Do not dispose of surplus material unless approved in writing.

Consider the quantity of surplus material shown in the plans to be approximate only. Determine that there is sufficient material available for the completion of the embankments within the areas involved before disposing of any indicated surplus material. Replace any shortage of material caused by premature disposal of the indicated surplus material.

Dispose of surplus material according to Subsection 107.14 after the requirements of this Subsection have been met.

**203.03.08 Selected Material.** When specified in the contract documents, use suitable selected material encountered in excavation for finishing the top portion of the subgrade.

Selected material shall be defined as material which is excavated and used for selective purposes.

Haul selected material directly from excavation to its final position on the roadbed and compact. Such work will be paid for at the contract unit price for the excavation item involved. See Subsection 104.04.

When the transporting of selected material directly from excavation to its final position is impractical, leave the selected material in place until it can be placed. No additional compensation will be made because of any such delayed excavation. If, however, the conditions are such that the undisturbed selected material will hamper ordinary grading operations or cause unnecessary movements of equipment, the removal and stockpiling of sufficient selected materials may be ordered in writing. Stockpile at approved locations. Place the stockpiled selected material in final position on the roadbed when approved.

Measurement for payment of selected material stockpiled as above provided will be according to Subsection 203.04.01 (d).

**203.03.09 Slides and Slipouts.** Excavate and remove material outside the planned roadway or ditch slopes which is unstable and constitutes potential slides in the opinion of the Engineer.

Excavate and remove material from slides which has come into the roadway or ditch, and material which has slipped out of new or old embankments as directed. Excavate material to designated lines or slopes in an approved manner. Dispose of such material or, if approved, use such material in the construction of embankments.

The above provisions do not relieve the duty of maintaining all slopes. Erosion, regardless of amount or extent, caused by the action of the elements which results in damage to work or materials, shall in no case be considered a slide or slipout.

Measurement for payment will be according to Subsection 203.04.01 (f).

**203.03.10 Drainage.** Maintain the roadbed so that it will be well drained at all times.

Construct V-type ditches to the cross section and dimensions on the plans by means of suitable equipment which will deposit all loose material on the downhill side.

In going from cut to fill, cut the roadway ditches to the right or left before reaching the fill so as to avoid damage to embankments by erosion.

Excavate the flat-bottom ditches indicated on the plans, or as staked, to the required cross section and grade. Use excavated materials, if approved, to construct roadway embankments or dikes or both to form a continuous diversion channel as staked.

To avoid destruction of natural growth during construction of ditches, channels, or dikes, confine travel of equipment to the construction limits as nearly as practicable. Where ditches, channels, or dikes are nearly parallel to the roadway, do not locate turnarounds closer than 300 m (1,000 ft) apart. See Subsection 107.12.

Fine grade channel bottoms only if paving is specified.

**203.03.11 Borrow.** In case designated borrow deposits fail to contain the necessary quantity of acceptable material, give notification in writing. If there is not sufficient quantity of acceptable material, the Engineer may designate an alternate deposit in which to obtain the deficit.

In borrow pits having undesirable material, including overburden, organic and deleterious substances, remove and waste or redistribute the material, in a satisfactory manner. Remove and dispose of all refuse.

Do not obtain borrow until all other excavation items are complete to the extent necessary to determine the need for borrow.

Give notification 10 days in advance of opening any borrow areas so that cross sections of the ground surface after stripping may be taken, and the borrow materials can be tested before being used.

Excavate borrow deposits to regular lines as staked to permit accurate measurement, if required. Make the depth of excavation throughout the area of the borrow pits as uniform as practicable. Construct side slopes conforming to Subsection 104.05. Excavate borrow pits so that they will drain to the nearest natural outlet.

Materials which are not satisfactory for use for the purposes intended will be rejected at the pit and shall be disposed of in a satisfactory manner.

Excess excavated material will not be measured for payment.

**203.03.12 Foundation for Embankment.** When embankment is to be placed and compacted on hillsides, or against existing embankments, or when embankment is to be built half width at a time, continuously bench the slopes that are steeper than 1:4 (4:1) as the work is brought up in layers. Bench with sufficient width to permit operations of placing and compacting equipment. Begin each horizontal cut at the intersection of the original ground and the vertical sides of the previous cuts. Recompact material thus cut out along with the new embankment material. If the width of the approved bench excavation exceeds 2 m (6 ft), the excavated material in excess of 2 m (6 ft) will be measured and paid for as roadway excavation.

Clear and grub foundations for embankment according to Section 201.

Where less than 0.3 m (1 ft) of embankment is to be placed over an existing bituminous or concrete surface, remove such surface and incorporate in the embankment or otherwise dispose of as approved. Removal of existing bituminous or concrete surface will be paid for as roadway excavation unless the contract documents specifically call for payment under Section 202.

**203.03.13 Embankment Material.** Construct embankments with suitable materials, excavated as prescribed and with any excess materials from other operations which are acceptable and suitable for use.

Use materials free from objectionable material such as leaves, grass, roots, logs, stumps, brush, or other perishable material.

When there is a choice of material and when practicable, make the excavation so that the best material will be placed in the uppermost layer of the embankment for at least 0.3 m (1 ft) in depth.

Stockpiling and subsequently rehandling embankment materials is not required except as provided in Subsection 203.03.08. Do not place material in the embankment when either the material, foundation or the embankment on which it would be placed is frozen.

Where embankments are to be made of material from rock cuts or other material which is unsuitable for finishing the roadbed, form the upper 150 mm (6 in.) of the roadbed with approved material.

**203.03.14 Placing Embankment.** For embankment or backfill deposited against structures, see Subsection 207.03.02.

Where structure abutments are placed on embankment, construct the embankment to subgrade elevation before excavating for the construction of the abutment. Where the abutment is supported on piles, construct the embankment to the elevation of the bottom of the footing.

Where structures are located under a rock embankment, cover the structures with not less than 0.6 m (2 ft) of satisfactory soil or granular materials before the embankment is placed over the structure.

Place in layers not exceeding 200 mm (8 in.) in thickness before compaction, except as hereinafter specified. Begin the construction of an embankment at the lowest point of the fill below the grade. Spread individual layers evenly to uniform thickness throughout and parallel with the finished grade for the full width of the embankment, unless otherwise permitted.

When native ground will not support the mass of heavy hauling and spreading equipment, choose equipment as will least disturb the soft foundation.

For approval to allow an increase in the planned layer thickness of embankment material over soft ground, satisfactorily prove that the planned depth is inadequate to support light hauling vehicles. Necessary use of lighter hauling vehicles or different methods of embankment construction other than originally contemplated shall not be the basis for a claim for extra compensation.

When approved, construct the lower part of the fill on the soft foundation by dumping and spreading successive vehicle loads in a uniformly distributed layer of a thickness not greater than that necessary to support the vehicle while placing subsequent layers. Construct the remainder of the embankment in layers and compact as specified.

When less than 70% of embankment material passes the 19 mm (3/4 in.) sieve, the material shall be considered "Rock Embankment." Spread such materials in a uniform horizontal layer over the full width of the embankment. Do not exceed a layer thickness of 4/3 times the vertical dimension of maximum size material larger than 200 mm (8 in.). The largest size rock allowed in the embankment will be 1 m (3 ft) measured in vertical direction. Break up any larger rocks before placing in the embankment. Dispose of rock exceeding 1 m (3 ft) in an approved manner.

In rock fills, do not directly end dump upon the previously constructed layer of embankment. Dump rock on the layer of embankment being constructed and doze ahead into place. Exercise care as much as practicable to work the fines and smaller rock into the spaces between the larger rock. Compaction will be required as provided in Subsection 203.03.16.

To the extent of project requirements for embankment, use all rock from excavation for embankment. Plan the grading operation to use rock which may be encountered in excavation according to the following provisions:

Place rock so as to form the base of embankments or in the side slopes.

Do not place rock in embankments where piles will be driven.

When rock and other embankment materials are excavated at approximately the same time, distribute the rock throughout the fill and do not nest in one location.

When there is insufficient material other than rock in the excavation to permit properly compacted layers, place the rock for the full cross-section width with the larger rocks well distributed and the void spaces filled with the smaller rocks and fragments.

At locations that are inaccessible to the roller, bring up the embankment in layers of the thickness specified and compact each layer with mechanical tampers or by hand tamping.

**203.03.15 Compaction, Embankment.** Optimum moisture content of the various soils will be determined. Wet or dry the material for each layer before compaction as required in order to bring its moisture content within the prescribed limits.

Route and distribute the hauling and leveling equipment full width over each layer of the fill in such a manner as to uniformly distribute the compaction afforded thereby. In addition to hauling and leveling equipment, provide compaction equipment that is specifically designed and manufactured for the purpose of compacting embankments. Work compaction equipment continuously with the grading equipment.

Compact the base of cuts, natural ground having less than 1.5 m (5 ft) of embankment, measured from the subgrade, and embankment material to not less than 90% of the maximum density as determined by Test Method No. Nev. T108. The in-place density will be determined by Test Method No. Nev. T102 or T103. When natural ground material is encountered that cannot be compacted to the required density, compaction requirements will be determined.

Compact all selected borrow and structure backfill placed within the limits of embankments shown on the plans to not less than 95% of the maximum density as determined by Test Method No. Nev. T108. The in-place density will be determined by Test Method No. Nev. T102 or T103.

Recompaction to the specified density may be required before placement of any subsequent course.

**203.03.16 Compaction, Rock Embankment.** Test compaction of rock embankments by proof rolling. Obtain and test compaction using construction methods and equipment as follows:

(a) Methods. Deposit, spread, and level the material full width of the embankment. Route and distribute hauling and leveling equipment over each layer of the fill in such a manner as to make use of the compaction afforded thereby. In addition, one of the rollers, vibrators, or compactors meeting the requirements set forth under (b) "Equipment" below, shall compact the embankment full width with a minimum of 3 complete passes for each layer of embankment. Work compaction equipment, at a speed not exceeding 8 km/hr (5 mph), continuously with the grading equipment.

Roll in a longitudinal direction along the embankment and generally begin at the outer edges and progress toward the center. Keep the travel paths of traffic and construction equipment dispersed over the entire width of the embankment so as to aid in obtaining uniform compaction. Masses of equipment used in making embankments may be limited, if, such limitations are necessary in order to maintain the fill in a satisfactory condition.

Apply water to the embankment in the amount necessary to obtain the required compaction.

(b) Equipment. Use compaction equipment to meet compaction requirements without adverse shoving, rutting, displacement, or loosening of the material. Display on rollers, in permanent legible characters, the manufacturer's guaranteed net operating masses as distributed on each axle. Masses of equipment used may be limited in order to maintain the fill and subgrade soils in a stable condition.

Sheepsfoot or tamping rollers shall consist of metal drums of shells equipped with uniformly spaced self-cleaning tamping feet. The mass and dimensions of the roller, the number, spacing, and dimensions of the tamping feet, and the provisions for adding ballast shall be such that required compaction is produced with the least number of passes. Continue rolling until the tamping feet "walk out" of the surface.

Pneumatic rubber-tired rollers shall be of an approved, self-propelled, reversible type and shall have tires of equal size which may be either treaded or smooth faced, but which shall all be the same. Wheels shall be equally spaced along both axle lines. The tires shall be arranged so that those on one axle track are midway between those on the other. Uniformly inflate tires so that the difference in the pressures in any two tires does not exceed 35 kPa (5 psi). Provide means for checking the tire pressure at any time. Adjust the tire inflation pressure and the wheel loads to that which produce required compaction with the least number of passes.

Do not use vibratory compactors unless approved.

(c) Tests. Do not place subsequent layers until the previous layer of the embankment is compacted to the degree that no further appreciable deflection is evidenced under the action of proof rolling equipment, as determined by the Engineer.

Rolling and proof rolling may be deleted on any layer or portion thereof when compaction is determined to be physically impractical.

Consider payment for rolling and proof rolling or for the correction of any subgrade weakness or deficiencies disclosed by the proof rolling operation subsidiary to the price bid for the "Excavation" item.

**203.03.17 Maintenance of Embankment.** Replace embankment material which may be lost or displaced as a result of natural settlement of the ground or embankment with acceptable material. The quantity of material required will be paid for at the contract unit price bid for the type of materials used.

Remove and replace with acceptable material, any embankment or portion thereof which has been constructed with unapproved material. Remove and replace portions of the embankment which may become unstable or displaced as the result of carelessness or negligence.

**203.03.18 Geotextile.** Grade the area to receive the geotextile to an even, smooth surface that is free of cavities, large stones, or other debris capable of puncturing or tearing the material. Do not place the geotextile until the surface has been approved.

Use equipment for installation that is recommended by the manufacturer and approved.

Unroll and place the geotextile parallel to the direction of placement of overlying material. Place the geotextile in direct contact with the surface without wrinkles or folds. Do not drive vehicles or construction equipment directly on the geotextile.

Do not damage the geotextile during the installation process. Avoid smearing the geotextile with mud or contaminating it with other foreign substances. Place the geotextile so that backfilling operations do not cause tearing or excessive stretching.

Join adjacent sheets and roll ends together by overlapping or sewing.

If adjacent sheets and roll ends are overlapped, then overlap upslope sheets over downslope sheets. Overlap roll ends and adjacent sheets a minimum of 0.3 m (1 ft). Maintain a minimum offset of 1.5 m (5 ft) between adjacent overlapped or sewn roll ends.

If adjacent sheets and roll ends are sewn, use a polypropylene or polyester thread with a color contrasting to the geotextile. Submit a seam assembly description including seam type, stitch type, sewing thread, and stitch density along with seam samples. Provide a certificate of compliance to verify that the seam strength meets a minimum of 90% of the required grab strength of the geotextile.

Limit atmospheric exposure of the uncovered geotextile to 10 days to minimize damage potential due to sunlight, rain, dirt, and contamination.

Do not cover the geotextile until it has been confirmed that no holes, tears, folds, wrinkles, or contaminated areas exist. Repair holes or tears by placing a new layer of geotextile over the defect that extends beyond the defect edges at least 0.3 m (1 ft) in all directions. Remove and replace contaminated areas with new geotextile.

Place overlying material by dumping from the edge of the geotextile, or from previously placed lifts.

Place a minimum thickness of 200 mm (8 in.) of overlying material on top of the geotextile before operating vehicles or construction equipment thereon. Do not turn construction vehicles on the first lift of material placed on top of the geotextile. If damage occurs to the geotextile from construction equipment or pumping of the subgrade, use small and lightweight equipment to reduce the weight on the geotextile. If rutting or bumps occur after the geotextile is placed, do not blade off the high spots.

## METHOD OF MEASUREMENT

**203.04.01 Measurement.** Excavation will be measured on a volume basis by cross sectioning the area to be excavated and computing neat lines for an end area. The average end area method will be used with no allowance made for curvature. If it is impossible or impractical to measure quantities by average end areas, the quantities will be computed by a method which is best suited to obtain an accurate determination.

Excavation will be measured by the cubic meter (cubic yard) of material excavated and placed as required. The estimated quantities shown on the plans, plus or minus authorized quantity changes, will be the quantity used for payment. The Engineer or the Contractor may, however, request a final measurement, in which case final cross sections will be taken. Submit request for final measurement in writing. When final cross sections are taken the determination of quantities derived therefrom will be the quantities used for payment. If the Contractor requests final measurement and the quantities thus determined are equal to or less than the planned quantities plus authorized changes, the Contractor shall reimburse the Department for the Department's expenses incurred by such final measurement.

When changes are made during construction such as widening cuts, changing grades, disposing of unsuitable material, stockpiling selected material and other changes resulting in increases or decreases in quantities, then additional measurements for payment will be made as hereinafter outlined:

(a) Unsuitable Material. When the removal and disposal of unsuitable material is shown in the contract documents, such material will be measured for payment as excavation for the related item.

Removal and disposal of unsuitable material, not shown on the plans, will be measured and paid for as "Roadway Excavation." However, if removal and disposal of unsuitable material not shown on the plans requires special equipment or unusual operations, it may be paid for as extra work according to Subsection 104.03.

No measurement will be made of suitable material temporarily removed and replaced to facilitate compaction of material.

(b) Overbreak. All sideslope overbreak, as defined in Subsection 203.03.05, will not be paid for.

Rock removed to a maximum depth of 150 mm (6 in.) below subgrade will be measured for payment provided the rock has been removed sufficiently to permit accurate cross sectioning. Replacement to this depth with material designated on the plans or approved will be measured and paid for at the contract unit price for the material used.

Rock loosened or removed in excess of 150 mm (6 in.) below subgrade will not be measured or paid for. When ordered, remove the loosened material and refill the resultant space with approved material at own expense.

(c) Widening Cuts. If directed to excavate beyond the limits of the typical cross section before the excavation is substantially completed, the material shall be classified as “Roadway Excavation” and paid for at the contract bid price. However, if widening cuts requires special equipment, or unusual and extra expense, it may be paid for as extra work according to Subsection 104.03.

(d) Selected Material. Selected material stockpiled as provided in Subsection 203.03.08, will be measured for payment as roadway excavation both in its original position and also from the stockpile. Measurement of the material taken from stockpile will be made of the volume actually removed.

(e) Surplus Material. Surplus excavated material will be measured for payment as roadway excavation and no further compensation will be allowed by virtue of the method of disposing, placing, or widening embankments caused from such surplus material.

(f) Slides and Slipouts. In the event of slides and slipouts, the Engineer and Contractor shall negotiate in each case and decide the relative difficulty of performing the work, and payment will be made either as “Roadway Excavation” or as extra work as provided in Subsection 104.03.

Where slopes have been previously completed, the cost of resloping required in areas where unstable material is removed will be paid for as extra work as provided in Subsection 104.03.

The cost of pioneering work necessary to make slide or slipout areas accessible to normal excavation equipment and the cost of necessary clearing and grubbing will be paid for as extra work as provided in Subsection 104.03.

Only those quantities of slide or slipout material which are authorized and actually removed will be measured for payment.

Excavation in excess of the staked or authorized cross section will not be measured for payment, except as outlined above.

Material used for surcharge, whether shown on the plans or ordered, will be measured for payment as roadway excavation or borrow. If the surcharge is to be placed and removed under the terms of the same contract, the material will be measured for payment both in its original position and also from the surcharge position.

V-type ditches will be measured by the linear meter (station, each 100 linear feet shall constitute a unit of measure) parallel to the ground. The volume of excavation for such ditches will not be measured for payment.

Excavation items will be measured for payment in their original position.

Borrow embankment or selected borrow embankment will be measured by the cubic meter (cubic yard). The estimated quantities shown on the plans, plus or minus authorized quantity changes will be the quantity used for payment. No allowance or other consideration shall be made for consolidation or displacement of the original ground. Borrow embankment or selected borrow embankment material placed outside of the staked or authorized cross section will not be measured for payment. The Engineer or the Contractor may, however, request a final measurement, in which case final cross sections will be taken. Submit request for final measurement in writing. When final cross sections are taken the determination of quantities derived therefrom will be the quantities used for payment. If the Contractor requests final measurement and the quantities thus determined are equal to or less than the planned quantities plus authorized changes, the Contractor shall reimburse the Department for the Department’s expenses incurred by such final measurement.

Geotextile, geogrid, and geomembrane will be measured by the square meter (square yard) of surface area covered. No allowance will be made for material overlap.

BASIS OF PAYMENT

**203.05.01 Payment.** The accepted quantities, measured as provided above, will be paid for at the contract price per unit of measurement for the pay items listed below that are shown in the proposal. Payment will be considered full compensation for the work prescribed in this Section.

Payment will be made under:

| Pay Item | Pay Unit |
|---|---|
| Roadway Excavation | Cubic Meter (Cubic Yard) |
| Drainage Excavation | Cubic Meter (Cubic Yard) |
| Channel Excavation | Cubic Meter (Cubic Yard) |
| Borrow Embankment | Cubic Meter (Cubic Yard) |
| Borrow Excavation | Cubic Meter (Cubic Yard) |
| Selected Borrow Embankment | Cubic Meter (Cubic Yard) |
| V-type Ditches | Linear Meter (Station) |
| Geotextile (class) | Square Meter (Square Yard) |
| Geogrid | Square Meter (Square Yard) |
| Geomembrane | Square Meter (Square Yard) |

# SECTION 206

## STRUCTURE EXCAVATION

### DESCRIPTION

**206.01.01 General.** This work consists of the removal of material encountered for the construction of selected structures and other excavation specifically designated as structure excavation. This work also includes the work of disposing of surplus material and cleaning up the sites. Structure excavation includes dewatering and the construction or installation of all cofferdams, cribs, shoring, and other facilities which may be necessary to perform the excavations and the subsequent removal of such facilities except where they are required or permitted to remain in place. It also includes the necessary clearing and grubbing within the proposed structure area and removing old structures or parts thereof as required if the proposal does not include separate bid items for such work.

For specific requirements pertaining to the excavation involved in the installation of pipe culverts and underground piping, attention is directed to those Sections of these specifications governing such work.

Design and construct shoring, cribbing, or cofferdams as required. Construct safe and adequate shoring, cribbing, or cofferdams to provide the necessary rigidity and support the loads imposed.

Submit 6 sets of design calculations along with detailed drawings of the shoring, cribbing, or cofferdams for approval according to Subsection 105.02. Such design calculations and drawings shall be prepared and stamped by a professional engineer registered as a Civil Engineer in the State of Nevada. If such plans are not satisfactory make such changes in them as may be required. Do not begin construction of such shoring, cribbing, or cofferdams until the drawings are approved.

Allow 30 days for Department review and approval of complete excavation shoring shop drawings. Allow an additional 60 days for such shop drawings that also require Railroad approval. Do not begin excavation shoring construction until shop drawings have been approved. No additional time will be provided for shop drawings submittals that are returned for correction by either the Department or the Railroad.

Follow OSHA safety regulations (29 CFR, Part 1926, Subpart P, Excavations) for sloping the sides of excavations, using shoring and bracing, and for using other safety features. When sides of excavations are sloped for safety considerations submit, for informational purposes, one copy of the design that demonstrates conformity with OSHA regulations. Where support systems, shield systems, or other protective systems are to be used, submit design calculations along with detailed drawings that demonstrate conformity with OSHA regulations. Submit the design calculations and detailed drawings according to Subsection 105.02.

**206.01.02 Classification.** Classification of structure excavation will not be made on the basis of materials or conditions encountered. Classification of excavation, if made, will be on the basis of the material removed between certain elevations, and such classification as shown on the plans or set forth in the Special Provisions shall not be changed regardless of the material encountered.

### CONSTRUCTION

**206.03.01 General.** Give notification at least 2 weeks in advance of the beginning of excavation so that elevations and measurements may be taken of the existing ground before it is disturbed and of existing substructure units within the limits of excavation for structures before they are removed. Material excavated or removed before these measurements have been taken will not be paid for.

Excavate to the established elevations and dimensions. Consider the elevation of the bottoms of footings as shown on the plans as approximate only. Changes in dimensions or elevation of footings as may be necessary to secure a satisfactory foundation may be ordered in writing.

Compact culvert pipe and structure foundations to not less than 90% of the maximum density as determined by Test Method No. Nev. T108. The in-place density will be determined by Test Method No. Nev. T102 or T103.

Cut rock or other hard foundation material to a firm surface, either level, stepped, or serrated. Clean the excavation of loose material. Clean out and fill seams and crevices with concrete mortar or grout.

Should foundation excavation be below grade, backfill to the required elevation with backfill or foundation fill with no additional payment.

Dewater wet excavations for inspection and for construction of foundations unless otherwise provided.

Utilize suitable excavated material for backfilling or in embankments. Dispose of surplus or unsuitable material so as to cause no obstruction to flow of streams, or otherwise impair the efficiency or appearance of the structure. Dispose in such a manner as to prevent damage to property or the creation of unsightly conditions, and do not place where it will interfere with the operation of drains or impair the roadway ditches, etc.

**206.03.02 Inspection.** After each excavation is completed, give notification, and do not place materials therein until the depth of excavation and the character of the foundation material have been approved.

## METHOD OF MEASUREMENT

**206.04.01 Measurement.** Structure excavation will be measured by the cubic meter (cubic yard) of material excavated and placed as required. The estimated quantities shown on the plans, plus or minus authorized quantity changes, will be the quantity used for payment.

The Engineer or the Contractor may, however, request recalculation of quantities. Submit request for recalculation of quantities in writing. When quantities are recalculated, the recalculated quantities will be used for payment.

The volume of water or any other liquid will not be included in the measurement for payment. The volume of mud, muck, or similar semi-solid matter not resulting from construction operations and which cannot be pumped or drained away shall be included.

## BASIS OF PAYMENT

**206.05.01 Payment.** The accepted quantities, measured as provided above, will be paid for at the contract price per unit of measurement for the pay item listed below that is shown in the proposal. Payment will be full compensation for the work prescribed in this Section.

No compensation will be made for the removal and disposal of material which may come into an excavation from outside the designated limits or for the removal and disposal of swell material resulting from the driving of piles in an excavation.

The limits of structure excavation shown in the plans shall be used for the method of measurement and payment only. Make the structure excavation limits outside the vertical planes 450 mm (18 in.) outside the structures according to the OSHA safety regulations. There will be no additional compensation for protective systems required by the OSHA regulations.

When plan quantities of structure excavation are based upon the use of shoring, no increase in structure excavation quantity will be allowed when shoring is eliminated.

When an item for structure excavation does not appear in the proposal, structure excavation will be considered as incidental to the installation of the structure and compensation shall be considered as being included in the contract prices for other items of work.

Payment will be made under:

| **Pay Item** | **Pay Unit** |
|---|---|
| Structure Excavation | Cubic Meter (Cubic Yard) |

# SECTION 207

## BACKFILL

### DESCRIPTION

**207.01.01 General.** This work consists of placing and compacting backfill or granular backfill material in excavations for bridges, retaining walls, headwalls, culverts, and other structures.

This work also consists of furnishing and placing slurry cement backfill as shown on the plans, or as an alternative to backfill or granular backfill. Applications include use as structural fill, pipe encasement, or pipe and trench backfill as approved. For placement adjacent to bridge structures, prior approval by the Bridge Engineer is required.

### MATERIALS

**207.02.01 General.** Material shall conform to the following Subsections:

| | |
|---|---|
| Backfill | Subsection 704.03.10 |
| Granular Backfill | Subsection 704.03.11 |

**207.02.02 Slurry Cement Backfill.** Slurry cement backfill shall consist of a workable mixture of various combinations of aggregate, cement, mineral admixtures, liquid admixtures, and water. Aggregate shall consist of a concrete, grout, or mortar aggregate as specified in Section 706.

Cement shall meet the requirements of Section 701. All approved cement types and blended cements or combination thereof may be used. Mineral admixtures shall meet the requirements of Section 702.

For approval, submit a mix design stamped by a Professional Engineer registered in the State of Nevada to ensure accordance with performance specifications listed herein. The mix design shall include a list of all ingredients, the source of materials, gradations of aggregates, types of admixtures, dosage rates, and batch weights. A change in the source of materials, gradation, or addition or deletion of admixtures may necessitate a new mix design and trial batch.

Provide test data from an accredited laboratory showing that the proposed mix design meets the performance specifications herein. Accreditation shall be obtained from the American Association of State Highway and Transportation Officials (AASHTO) or the American Association for Laboratory Accreditation (A2LA).

A mix design having prior acceptance by the Department, local municipalities, or utility companies may be approved if documentation of test results and past field performance is provided.

Submit slurry cement mix designs conforming to one of the following classes of flowable fill, A or B, depending on the application. The type of application shall be shown on the plans or be as determined by the Contractor and approved. Determine proportioning as shown on the approved mix design. The trial batch and subsequent placements shall produce a mix consistency that will result in a flowable self-leveling product at the time of placement.

| | **Excavatable** | **Non-Excavatable** |
|---|---|---|
| **Class** | **A** | **B** |
| 28 Day Strength | 340-1,400 kPa (50-200 psi) | 1,400-6,900 kPa (200-1,000 psi) |
| Air Content | 5% Min. | 5% Min. |
| Subsidence | 1% Max. | 1% Max. |

The use of air entrainment, air generators, or foaming agents may be needed to meet the performance specifications. The 28 day compressive strength testing and sampling will follow the procedure set forth in Test Method Numbers Nev. T428 and ASTM C39, except cylinders shall not be rodded during sampling. The air content will be determined by Test Method No. Nev. T431 or T432. Subsidence will be tested according to ASTM C940, except a standard 152 mm by 305 mm (6 in. by 12 in.) cylinder may be used for measurement purposes. Subsidence is defined as settlement or bleeding and shall not exceed 1%. Mixtures that require placement by use of a concrete or grout pump will be allowed a maximum subsidence of 2%. Slump tests may be performed on a random basis using Test Method No. Nev. T438 for the purpose of controlling consistency at the job site.

CONSTRUCTION

**207.03.01 General.** Compact with mechanical tamping units.

Compact foundations for culvert pipe to not less than 90% of the maximum density and for reinforced concrete boxes to not less than 95% of the maximum density as determined by Test Method No. Nev. T108. The in-place density will be determined by Test Method No. Nev. T102 or T103.

Place backfill material in uniform horizontal layers not exceeding 200 mm (8 in.) in loose thickness before compaction. Bring up uniformly on all sides of the structure or improvement. Moisten each layer of backfill as necessary and compact thoroughly until 90% of the maximum density is achieved. Compact each layer of backfill placed for abutments, piers, retaining walls, and wingwalls for bridges until 95% of the maximum density is achieved as determined by Test Method No. Nev. T108. The in-place density will be determined by Test Method No. Nev. T102 or T103.

Do not compact backfill material by ponding or jetting.

Deposit material resulting from structure excavation, not used as backfill, in roadway embankments according to Section 203 or otherwise dispose of along the roadway in an approved manner.

Do not place backfill material until the structure or facilities have been inspected and approved for backfilling. Do not deposit backfill material against the back of concrete abutments, concrete retaining walls or the outside walls of concrete box culverts until the concrete has reached an age of 14 days or the concrete has developed a compressive strength of 17 MPa (2,500 psi) as determined by ASTM C39.

Where backfill is placed against waterproofed surfaces, take care not to damage the waterproofing material.

**207.03.02 Placing and Compacting at Abutments, Piers, and Walls.** Where backfill is to be placed on one side of an abutment, wingwall, pier, retaining wall, or headwall, exercise care during placement and compaction of backfill material to prevent over compacting to the point of displacing line or batter or both.

Step-cut or bench existing slopes which are shaped so as to cause a wedge action in the backfill, before backfilling.

**207.03.03 Placing and Compacting at Culverts.** Place backfill along both sides of the culvert equally in uniform layers not exceeding 200 mm (8 in.) in loose thickness before compaction.

Take care in placing and compacting the material under the haunches of pipe.

Continue backfilling as described to the level of the ground or to an elevation 150 mm (6 in.) above the structure in the case of a pipe culvert in projection, or even with the top of the structure in the case of a RCB culvert in projection.

Do not allow construction equipment or other traffic to cross any culvert until a safe minimum depth of fill above the culvert has been placed and compacted. Protect the structure from superimposed loading created by construction equipment. Repair any damage done to the structure or replace the structure without extra compensation.

Take care in backfilling arches. Cover arches in layers conforming to the shape of the arch and tamp thoroughly.

**207.03.04 Slurry Cement Backfill Placement.** Manufacture slurry cement backfill at plants that qualify as approved sources for ready-mix concrete suppliers and deliver to the site in transit-mix trucks.

After delivery and immediately before discharge, agitate the mix at mixing speed for a minimum of 70 revolutions.

Discharge or pump the mix from the transit-mix truck into the space to be backfilled.

When backfilling pipe culverts, distribute the mix evenly to prevent movement of the pipe. Placement may be required in stages to prevent uplifting of the pipe. Take appropriate measures such as installing straps or soil anchors to secure pipes from movement during fill placement.

Do not place slurry cement backfill on frozen ground. Protect slurry cement backfill from rapid surface moisture loss and from freezing for 36 hours after placement.

Do not allow vehicle traffic or placing of pavement surfaces thereon until a penetration resistance of 4.1 MPa (600 psi) has been achieved using a hand held penetrometer according to ASTM C403. This penetration will be considered achieved when a person weighing at least 68 kg (150 lb), by use of their body mass as an axial load, cannot penetrate the slurry cement backfill with the square cut end of a No. 13 (#4) steel reinforcing bar.

## METHOD OF MEASUREMENT

**207.04.01 Measurement.** Backfill, granular backfill, and slurry cement backfill will be measured by the cubic meter (cubic yard). The estimated quantities shown on the plans, plus or minus authorized quantity changes, will be the quantity used for payment.

The Engineer or the Contractor may, however, request recalculation of quantities. Submit request for recalculation of quantities in writing. When quantities are recalculated, the recalculated quantities will be used for payment.

## BASIS OF PAYMENT

**207.05.01 Payment.** The accepted quantities, measured as provided above, will be paid for at the contract price per unit of measurement for the pay items listed below that are shown in the proposal. Payment will be full compensation for the work prescribed in this Section.

The limits of backfill, granular backfill or slurry cement backfill shown in the plans shall be used for the method of measurement and payment only. There will be no additional compensation for any additional backfill materials required for excavations required to meet the OSHA regulations or for the elimination of shoring.

When material from structure excavation is unacceptable as backfill and backfill material is obtained from roadway excavation, borrow or from base materials, it will be paid for both as backfill and the respective bid item from which it is obtained. When granular backfill is called for, it will be paid as granular backfill only.

When an item for backfill does not appear in the proposal, backfill will be considered as incidental to the installation of the structure and compensation shall be considered as being included in the contract prices for other items of the work.

Payment will be made under:

| **Pay Item** | **Pay Unit** |
|---|---|
| Backfill | Cubic Meter (Cubic Yard) |
| Granular Backfill | Cubic Meter (Cubic Yard) |
| Slurry Cement Backfill | Cubic Meter (Cubic Yard) |

# SECTION 209

## DRAIN BACKFILL

DESCRIPTION

**209.01.01 General.** This work consists of furnishing, hauling, placing, and compacting drain backfill material around structures or perforated underdrains.

MATERIALS

**209.02.01 General.** Material shall conform to the following Subsection:

Drain Backfill ..... Subsection 704.03.01

CONSTRUCTION

**209.03.01 General.** Compact drain backfill to the satisfaction of the Engineer.

Do not compact by ponding or jetting.

**209.03.02 Underdrains.** Excavate and place drain backfill according to Section 607.

METHOD OF MEASUREMENT

**209.04.01 Measurement.** Drain backfill will be measured by the cubic meter (cubic yard).

BASIS OF PAYMENT

**209.05.01 Payment.** The accepted quantities, measured as provided above, will be paid for at the contract price per unit of measurement for the pay item listed below that is shown in the proposal. Payment will be full compensation for the work prescribed in this Section.

Payment will be made under:

| **Pay Item** | **Pay Unit** |
|---|---|
| (type) Drain Backfill | Cubic Meter (Cubic Yard) |

# SECTION 211

## EROSION CONTROL

### DESCRIPTION

**211.01.01 General.** This work consists of salvaging topsoil, furnishing and placing topsoil, seeding, hydro-seeding, placing erosion control fabric, and applying soil stabilizer on graded and disturbed areas.

Coordinate erosion control work with the Storm Water Pollution Prevention Plan (SWPPP).

Coordinate erosion control work with NPDES Phase 2 permit requirements.

Per NPDES Phase 2 permit requirements, 70% of pre-disturbance native plant cover shall be achieved before the Notice of Termination (NOT) can be issued. If adequate coverage is not achieved, reapply all components of erosion control treatment.

Unless the project site is irrigated, perform seeding and hydro-seeding from September 15 to February 15 for any year.

Apply erosion control work within 60 days of finish grading unless this date falls outside of September 15 to February 15. Apply erosion control treatments per specifications and the Department's Best Management Practice Manual within 30 days of finish grading to all areas not treated between September 15 and February 15.

Upon completion of installation and approved inspections, provide a certification letter from a Certified Professional in Erosion and Sediment Control (CPESC) that the project has been installed in accordance with the approved plans and Department approved changes.

In addition to the requirements in Section 637, do not allow Cheatgrass (Bromus tectorum) or Red Brome (Bromus rubens) within the project area. Remove weeds by hand or treat with herbicides approved for use on the QPL and apply according to manufacturer's directions.

### MATERIALS

**211.02.01 General.** Material shall conform to the following Section:

Roadside Materials ..... Section 726

The rates of application of amendments, inoculants, seed, mulch, tackifier, and soil stabilizer will be specified in the contract documents.

### CONSTRUCTION

**211.03.01 Topsoil (Salvage).** Topsoil (salvage) consists of removing existing topsoil, stockpiling, treating if required, preparing areas for placement, placing at designated areas, and compacting.

Remove existing topsoil to a depth of 150 mm (6 in.) maximum or as shown or specified. Screen the material according to Subsection 726.03.02. Stockpile this material in approved areas.

Do not stockpile topsoil more than 1.8 m (6 ft) in height and do not compact stockpiles. Stabilize stockpiles of topsoil that are in place for less than 1 month with water or dust palliative. Dust palliative shall not inhibit vegetative growth. For topsoil stockpiles in place more than 1 month, apply an erosion control treatment to the stockpile consisting of a slurry with seed, soil inoculant, mulch, tackifier, water, and amendments as specified. Maintain stockpiles using Best Management Practices in accordance with NDOT's Construction Site Best Management Practices Manual.

If areas for topsoil stockpiles are limited and require stockpiling at heights greater than 1.8 m (6 ft) in height, apply an erosion control treatment as specified above.

Prepare final placement areas by cultivating and roughening slopes with rippers, discs, or other approved equipment, in the direction with the contours where possible to a depth of 150 mm (6 in.).

Do not perform cultivation until all other equipment is through working in the area.

Operate equipment such that furrows are produced perpendicular to the natural flow of water.

Transport topsoil directly from the stockpile to final position. Evenly and uniformly spread topsoil to a depth of 75 mm (3 in.). If needed, moisten with water as directed to increase the bond between the topsoil and subsoil. The topsoil finished surface shall conform to the finished grade contours depicted on the grading plans.

Do not place topsoil when the ground or topsoil is frozen, excessively wet, or not in an acceptable condition to facilitate uniform spreading.

Compact topsoil in accordance with Subsection 211.03.03.

**211.03.02 Topsoil.** Topsoil consists of preparing areas for placement, transporting topsoil from approved sources, placing the topsoil at designated areas, and compacting.

Prepare final placement areas by cultivating and roughening slopes with rippers, discs, or other approved equipment, in the direction with the contours where possible to a depth of 150 mm (6 in.).

Do not perform cultivation until all other equipment is through working in the area.

Operate equipment such that furrows are produced perpendicular to the natural flow of water.

Transport approved topsoil directly from the source to final position. Evenly and uniformly spread topsoil to a depth of 75 mm (3 in.). If needed, moisten with water as directed to increase the bond between the topsoil and subsoil. The topsoil finished surface shall conform to the finished grade contours depicted on the grading plans.

Do not place topsoil when the ground or topsoil is frozen, excessively wet, or not in an acceptable condition to facilitate uniform spreading.

Compact topsoil in accordance with Subsection 211.03.03.

**211.03.03 Compaction.** Compact topsoil by sheepsfoot roller, cleated crawler tractor, or similar approved equipment which will produce 1,000 to 2,000 kPa (150 to 300 psi) ground pressure to produce final compaction of topsoil that is approximately 70 to 80 percent of the relative maximum density. Design and construct equipment to produce a uniform rough textured surface consisting of small undulations that trap surface runoff and break up surface flow continuity, and which will bond the topsoil to the underlying material. Operate compaction equipment parallel to the natural flow of water on the slopes or perpendicular to the contour of the slopes, unless otherwise approved. Convey the roller or approved equipment up and down the slopes by approved means. Finish grade of the topsoil to be 25 mm (1 in.) below the top of curbs, catch basins, and other structures.

To condition the topsoil for compaction, furnish a suitable amount of water and apply by approved methods. Moisten topsoil with water to bind topsoil together.

**211.03.04 Soil Amendments and Inoculants.** Apply inoculant at a rate of 56 kg per hectare [50 pounds per acre (82 spores/$ft^2$)].

The application rates for soil amendments will be specified in the Special Provisions.

**211.03.05 Seeding.** Seeding consists of applying soil amendments and inoculants, preparing the areas, applying seed, and applying mulch and tackifier.

Furnish and apply soil amendments and inoculants at the rates specified in Subsection 211.03.04.

Evenly apply soil amendments and inoculants to the areas to be seeded. If applied hydraulically, mix soil amendments and inoculants in a tank equipped with an agitator so that a uniform suspension is achieved and maintained. The amendments and inoculants shall not remain in the tank longer than 1 hour.

Mix amendments and inoculants into soil and prepare the seeding areas by tilling the soil to a minimum depth of 150 mm (6 in.). Operate equipment such that furrows are produced perpendicular to the natural flow of water. Remove and dispose of all rocks larger than 150 mm (6 in.) in smallest dimension from the surface of slopes to be seeded.

Give a minimum of 48 hours notification in advance of any seeding operations for approval of the seeding areas. After approval, seeding of the approved areas may begin.

Materials for seeding shall be batched on site under the observation of the Department or designated representative.

Provide qualified personnel experienced in all phases of seeding, equipment, and methods as herein specified.

Do not seed when there are sustained winds of 21 km/hr (13 mph) or more, or conditions that may cause material to disperse or apply inaccurately. Do not seed when the ground is frozen. Uniformly spread seed at the rate and mix specified.

On slopes 3:1 (horizontal to vertical) or flatter, seeding shall be accomplished by drill seeding. All other areas shall be seeded by hydro-seeding.

Perform drill seeding with approved power-drawn drills with double-disc front delivery openers and depth bands for positive depth control. Set depth control at a depth of 19 mm (3/4 in.) for consistent furrow bottom placement. An approved deep furrow drill may be used where it is determined the seedbed is firm and there is little danger of soil blowing. An approved spreader may be used for fertilizer placement. Calibrate drills and spreaders using an approved method before use.

Perform hydro-seeding with an approved type hydro-seeder which utilizes water as the carrying agent (hydraulic) and maintains a continuous agitator action that will keep seed and additives mixed in uniform distribution until pumped from the tank. Maintain pump pressure to maintain a continuous, non-fluctuating stream of solution.

Areas that cannot be drill seeded or hydro-seeded shall be seeded by an approved method. Uniformly distribute the material at the rates specified.

Apply mulch and tackifier in accordance with Subsection 211.03.06.

**211.03.06 Mulch.** Within 24 hours after each area is seeded, straw mulch shall be applied, crimped, and tacked. Uniformly apply mulch by means of an approved type mulch spreader at the minimum rate of 4.5 metric tons per hectare (2 tons per acre). The spreader shall produce a uniform distribution of the straw, without cutting or breaking it into short stalks.

Crimp mulch by anchoring it into the soil with a heavy disc, sheeps-foot roller, or similar approved equipment. Discs shall be flat and serrated, with at least 6 mm (1/4 in.) thickness having dull edges, and spaced no more than 225 mm (9 in.) apart. Straw mulch shall be anchored to a depth of at least 50 mm (2 in.) and shall not be covered with an excessive amount of soil. Anchoring operations shall be across the slopes where practical, with no more than two passes of the anchoring equipment. Immediately following the crimping operation, the crimped area shall be tacked.

Tack mulch using a slurry consisting of a minimum of 168 kg of tacking agent, 560 kg of thermally refined wood fiber mulch, and 336 kg of water per hectare (150 pounds of tacking agent, 500 pounds of thermally refined wood fiber mulch, and 300 gallons of water per acre). The slurry shall contain a color additive which will assist the applicator in the uniform application of the mixture.

Apply the slurry with approved hydraulic equipment. Use equipment with a built in agitation system with an operating capacity sufficient to agitate, suspend, and homogeneously mix the specified portions of the slurry. Equip distribution and discharge lines with a set of hydraulic discharge spray nozzles which will provide a uniform distribution of the slurry.

Do not disturb surface areas after mulching and tacking is complete. Repair damaged areas as directed.

**211.03.07 Hydro-seeding.** Hydro-seeding consists of applying soil amendments and inoculants, preparing the areas, and applying a slurry mix of seed, mulch, and tackifier.

Furnish and apply soil amendments and inoculants at the rates specified in Subsection 211.03.04.

Evenly apply soil amendments and inoculants to the areas to be hydro-seeded. If applied hydraulically, mix soil amendments and inoculants in a tank equipped with an agitator so that a uniform suspension is achieved and maintained. The amendments and inoculants shall not remain in the tank longer than 1 hour.

Mix amendments and inoculants into soil and prepare the hydro-seeding areas by tilling the soil to a depth of 150 mm (6 in.). Operate equipment such that furrows are produced perpendicular to the natural flow of water. Remove and dispose of all rocks larger than 150 mm (6 in.) in smallest dimension from the surface of slopes to be hydro-seeded.

Give a minimum of 48 hours notification in advance of hydro-seeding operations for approval of the hydro-seeding areas. After approval, hydro-seeding of the approved areas may begin.

Materials for hydro-seeding shall be batched on site under the observation of the Department or designated representative.

Provide qualified personnel experienced in all phases of hydro-seeding, equipment, and methods as herein specified.

Do not hydro-seed when there are sustained winds of 21 km/hr (13 mph) or more, or conditions that may cause material to disperse or apply inaccurately. Supply certified instruments or data from certified instruments for verification of wind velocity, if directed. Do not hydro-seed when the ground is frozen.

Apply the slurry (seed, mulch, and tackifier) in one application with a hydro-seeder which utilizes water as the carrying agent (hydraulic) and maintains a continuous agitator action that will keep the slurry mixed in uniform distribution until pumped from the tank. Maintain pump pressure to maintain a continuous, non-fluctuating stream of solution. Use enough water to ensure even distribution. Apply slurry within 1 hour of mixing.

Do not disturb surface areas after hydro-seeding is complete. Repair hydro-seeded areas that are disturbed or damaged by re-application of hydro-seeding.

It is anticipated that 20% of the hydro-seeded area shall require an additional application. Areas requiring re-application will be determined. Apply the additional application within one year of the initial application.

**211.03.08 Erosion Control Fabric.** Place erosion control fabric parallel to the flow of water. Place immediately following final grading, or immediately following seeding/hydro-seeding if such work is required. Overlap fabric a minimum of 150 mm (6 in.) with the up-grade section on top. Bury the up-slope end of each strip of fabric in a 150 mm (6 in.) key trench with the soil firmly tamped against it. Any other edge exposed to more than normal flow of water or strong prevailing winds may be required to be buried in a similar manner. Place key trenches between the ends of strips by placing a tight fold of the fabric at least 150 mm (6 in.) vertically into the soil. Tamp and staple the fabric at the check slots the same as up-slope ends. Space check slots so that one check slot or one end occurs within each 15 m (50 ft) of slope.

Bury edges of fabric around the edges of catch basins and other structures as herein described. Spread fabric evenly and smoothly and in contact with the soil at all points.

Fasten fabric by approved wire staples, pins, spikes, or wooden stakes driven vertically and flush with the soil. Fasten fabric at intervals not more than 1 m (3 ft) apart in 3 rows for each strip of fabric. Place one row along each edge and one row alternately spaced in the middle. Fasten all ends of the fabric and check slots at 150 mm (6 in.) intervals across their width.

**211.03.09 Soil Stabilizer.** Complete all landscape planting as provided for in Section 212 prior to applying soil stabilizer.

Mix and apply the soil stabilizer when weather conditions are suitable and as recommended by the manufacturer.

Do not add herbicides or soil sterilizers to the soil stabilizer.

Prior to applying soil stabilizer, track-walk all accessible disturbed areas or operate equipment such that furrows are produced perpendicular to the natural flow of water (parallel to contours).

Apply soil stabilizer according to the plans. Do not disturb treated surface areas after soil stabilizer has been applied. If areas are subsequently disturbed or damaged, repair area by re-application of soil stabilizer. Protect buildings, walls, landscaping, and other objects within the vicinity from over spray.

Store, handle, and apply soil stabilizer per manufacturer's recommendations.

Add a color pigment to the soil stabilizer at the time of application.

Soil stabilizer shall form a crust like barrier within 4 to 8 hours. The use of accelerators is recommended.

Non-decorative rock areas to receive soil stabilizer shall be compacted to a minimum of 90% relative density prior to placement of soil stabilizer. Place soil stabilizer in these areas in accordance with manufacturer's recommendations.

Do not use fiber mulch products in traffic areas.

## METHOD OF MEASUREMENT

**211.04.01 Measurement.** Topsoil (Salvage) will be measured by the cubic meter (cubic yard).

Topsoil will be measured by the cubic meter (cubic yard) in the haul conveyance at the point of delivery.

Seeding, hydro-seeding, and soil stabilizer will be measured by the hectare (acre) or square meter (square yard).

Erosion control fabric will be measured by the square meter (square yard) of surface covered. No allowance will be made for material overlap.

The estimated quantities shown on the plans, plus or minus authorized changes, will be the quantity used for payment. The Engineer or the Contractor may, however, request recalculation of the quantities. Submit request for recalculation of quantities in writing. When quantities are recalculated, the recalculated quantities will be used for payment.

## BASIS OF PAYMENT

**211.05.01 Payment.** The accepted quantities, measured as provided above, will be paid for at the contract price per unit of measurement for the pay items listed below that are shown in the proposal. Payment will be full compensation for the work prescribed in this Section.

Payment will be made under:

| Pay Item | Pay Unit |
|---|---|
| Topsoil (Salvage) | Cubic Meter (Cubic Yard) |
| Topsoil | Cubic Meter (Cubic Yard) |
| Seeding | Hectare (Acre) or Square Meter (Square Yard) |
| Seeding (type) | Hectare (Acre) or Square Meter (Square Yard) |
| Hydro-seeding | Hectare (Acre) or Square Meter (Square Yard) |
| Hydro-seeding (type) | Hectare (Acre) or Square Meter (Square Yard) |
| Erosion Control Fabric | Square Meter (Square Yard) |
| Soil Stabilizer | Hectare (Acre) or Square Meter (Square Yard) |

# SECTION 212

## LANDSCAPE AND AESTHETICS

DESCRIPTION

**212.01.01 General.** The work consists of constructing landscape and aesthetic features.

MATERIALS

**212.02.01 General.** Material shall conform to the following Section:

Roadside Materials ..... Section 726

**212.02.02 Nomenclature.** Nomenclature for plant names and varieties shall be according to the latest edition of “Standardized Plant Names” as prepared by the American Joint Committee on Horticultural Nomenclature.

Plants will be grouped as follows:

Plants, Group A ..... containerized plant material
Plants, Group B ..... balled and burlapped plant material
Plants, Group C ..... ground cover

* The size of containerized plant material will be indicated in the description of the particular bid item. For example, Plants (Group A-2) denotes a #2 Container Size, Plants (Group A-5) a #5 Container Size, and so on.

**212.02.03 Quality of Plant Materials.** Provide plant material meeting the standards as set forth herein. During inspections plant material will be judged and rejections will be based upon these standards.

Plants shall comply with Federal and State laws requiring inspection for plant diseases and infestations. Inspection certificates required by law shall accompany each shipment of plants. Submit inspection certificates upon plant delivery.

Plant material shall be per the standards of the American Standards for Nursery Stock and shall be symmetrical, typical for variety and species, sound, healthy, vigorous, free from plant disease, insect pests or their eggs, mechanical injury (trunk or bark wounds), excessive abrasions, or other disfigurements, and shall have healthy, normal root systems, well fitting their containers, but not to the point of being root bound. Roots that are kinked girdling, circling or J roots will be rejected. Plant material shall be sturdy and well hardened off. Trees and shrubs shall not be pruned prior to delivery. Trees with damaged, cut, or topped central leaders will not be accepted. Plant material shall have normally well developed branch systems with undamaged straight central leader and well balanced tops.

Trees grown staked in a nursery will not be accepted unless stakes have been removed for a minimum of two years before the trees are dug from the nursery. A certification of this condition shall be provided at or before delivery of trees to the site.

Plant nomenclature shall be defined by the Plant Schedule or Plant Legend located on the plans. Plants shall be the variety and size shown. Plants shall be tagged with their botanical and common plant name. Plants shall be grown under climate conditions similar to those in the locality of the project, including USDA Zone.

Plants will be evaluated for root condition, size (above ground), insects, insect eggs, larva, disease free condition, general appearance (color, shape, prior pruning), damage from shipping including broken branches, and identification tags. A deficiency in any one of these elements will be sufficient reason to reject selectively or by lot.

**212.02.04 Handling and Shipping.** Pack plants for shipment according to standard practice for the type of plant being shipped. Do not allow the root system of plants to dry out at any time. Protect plants at all times against heat, freezing temperatures, sun, winds, climatic, and seasonal conditions during transit. Furnish plant material in containers unless otherwise specified. Handle all plants specified balled and burlapped (B&B) by the ball of earth and not the plant. Broken or “made” balls, or balled and burlapped plants placed in a larger container will not be accepted. Supply container grown plants well developed with sufficient root development to hold the earth intact after removal from the container without being root bound.

Plant material, except bareroot plants, shall be hardened material. Accomplish this by storing plants in a local licensed commercial nursery or by providing equivalent storage and care with written approval, for not less than 2 weeks before planting.

Before moving plants from nursery or storage area to the site, thoroughly spray them with a solution of an anti-desiccant/anti-transpirant conforming to the following requirements:

1. The material shall be in liquid form capable of application by spraying or dipping.

2. Upon drying, the mixture shall produce a gas-permeable, water retarding, colorless film having a moisture-vapor-transmission value of not more than 2.5. This requires that not more than 160 mg (2.5 grains) of water pass through the film in 24 hours at 38 °C (100 °F) and relative humidity of 90 to 95%. The procedure for testing shall be according to ASTM E96 or Technical Association of the Pulp and Paper Industry publication T464m-45.

Furnish two certificates from the manufacturer covering anti-desiccant/anti-transpirant material, certifying that the product complies with the specifications. Deliver the certificates at the time of, or before delivery of the order.

**212.02.05 Inspection of Plant Material.** Provide notification within 60 days following award of the contract, of the source of plant material. Include a statement from the supplier that the order was received and accepted by said supplier. Include in this statement, plant species, container sizes, and estimated of delivery dates. Inspection of plant materials at the source may be required before shipping of plants from the nursery. This inspection shall coordinate the judgment areas regarding size and quality of plant material between the Department, the Contractor, and the Nursery. However, there will be no acceptance of any plant material during this inspection.

Plant material will be inspected on arrival at the storage area. Give notification at least 48 hours prior to plant material delivery to arrange for inspection. This inspection will determine the acceptance or rejection of the plant material based on quality as specified in Subsections 212.02.03 and 212.02.04. This inspection is for quality of plant material and does not constitute final acceptance. Immediately remove rejected plants from the holding area and supply replacements.

**212.02.06 Substitution of Plants.** Do not substitute plant material unless evidence is submitted in writing from at least 3 suppliers that a specified plant cannot be obtained and has been unobtainable since the award of the contract. Substitutions will only be allowed with written approval prior to shipment and at no additional cost to the Department.

**212.02.07 Temporary Storage.** Immediately plant the material delivered and accepted. “Heel-in” plants that cannot be planted within one day after arrival according to accepted horticultural practice, and as follows:

1. Protect balled and burlapped plants by moist earth, sawdust, or other acceptable material.

2. Provide a shaded shelter for containerized plants.

Protect plants stored under temporary conditions at all times from extreme weather including excessive sun and drying winds, mechanical damage, conditions which would damage or impair their vigor, foot traffic, and vandalism. Plants shall be temporarily irrigated and maintained in a moist condition at all times during shipping, upon arrival to site, and in temporary storage area.

**212.02.08 Pre-emergent.** Pre-emergent herbicide shall be a non-selective pre-emergent herbicide, appropriate for the season. Apply pre-emergent herbicide before and after installation of decorative rock.

For existing weed growth, treat areas with an approved herbicide.

Use pre-emergent products that shall control the growth and spreading of the Russian Thistle (Salsola species). Submit product data for approval prior to using in the areas specified herein.

**212.02.09 Lumber.** Lumber for header boards and plant boxes shall conform to Section 718.

CONSTRUCTION

**212.03.01 Site Preparation.** Complete work on roadway construction, drainage facilities, cleaning, and grading before beginning preparation of the planting areas.

After final grading operations have been completed and prior to planting, add fertilizers and amendments at the rates specified in the Special Provisions.

**212.03.02 Layout of Planting and Mulch.** Designate by means of stakes or other approved markings, the ground location of each random plant and edge location of planting beds and mulch areas. Mark areas of massed or uniform solid plantings at their outer extremes only.

Allow 48 hours for review, modification, and approval of layout prior to commencement of the preparation of planting areas. Make revisions to layout as directed.

**212.03.03 Preparation of Planting Areas.** Remove clods, rocks, or other debris over 25 mm (1 in.) in largest dimension from both cultivated areas and backfill material, and dispose of according to Subsection 107.14. Load, haul, and dispose of any unsuitable material. The cost of disposing unsuitable material will be paid as extra work as provided in Subsection 104.03.

(a) Planter Boxes. Backfill material will be specified in the Special Provisions. Thoroughly and uniformly mix this material before placing in the planter boxes. After placing in the planter box, water the material until it is completely saturated. Add sufficient backfill mixture and adequately wet so that after settlement has taken place, the material is approximately 50 mm (2 in.) below the top of the box.

(b) Planting Beds. Initiate the soil preparation after all grading has been completed and the irrigation system has been installed, tested, adjusted, and accepted. Loosen and thoroughly pulverize the ground surface within the area to a depth of 150 mm (6 in.). Incorporate humus, commercial fertilizer, and other amendments at the rate specified in the contract documents, and thoroughly and uniformly till into the soil to a depth of 150 mm (6 in.). Bring the area to a plane in conformance to the elevations shown on the plans. Consolidate the area to be planted with approved cultipackers or rollers not to exceed 80% compaction.

(c) Seed Beds. Prepare the soil as specified for planting beds.

(d) Planting Holes. Before excavating holes, designate the proposed location of the irrigation lines by means of stakes or other approved markings. In the event of conflict between individual planting holes and irrigation lines, excavate the planting holes in question before installing the irrigation lines.

Hand or mechanically excavate plant holes. Dig holes at the location of each individual plant, with the stake or marking being considered the center of the hole. Scarify the sides of planting holes, if necessary to insure soil is loosened and not sealed.

After excavation and before backfilling, fill the plant pits twice with water. Should the pits fail to drain at a minimum drainage of 150 mm (6 in.) of water height in pit per hour give notification of this condition and suggest a remedy. Do not proceed with planting operations until directed.

Incorporate humus, soil amendments and fertilizers at the rates specified and uniformly mix with the material removed from the holes prior to backfilling. Before backfilling of holes, provide a sample of the backfill mix and mixing procedures for review. This sample will be used as reference material for the backfill mix as the project proceeds. Uniformly mix the soil amendments into the backfill for a homogeneous composition without balls, clumps, or layers of individual materials. Prepare the backfill near the plant pit or mix backfill offsite. Either option shall be approved before the beginning of planting operations.

Incorporate fertilizer as specified. If fertilizer starter tablets are used, place in the backfill mixture of each planting hole at a minimum of 100 mm (4 in.) and a maximum of 200 mm (8 in.) below ground level. The number and size of tablets in each planting hole shall be as specified.

After backfilling the holes, saturate the material with water to the full depth of the hole and until ponding appears in the basin. Place sufficient backfill material so that after planting and settlement has taken place, the basin will conform to the section as shown on the plans.

(e) Planting Trenches. Excavate trenches to the dimensions specified and center on the planting line as staked or otherwise marked.

Incorporate humus, commercial fertilizer, and other additives at the rates specified and thoroughly and uniformly mix with the material removed from the trenches before backfilling. After backfilling the trenches, saturate the material with water to the full depth of the trench.

Cross checks may be formed as necessary to permit ponding of water during the saturation period but shall be removed before planting. Place sufficient backfill material so that after planting and settlement has taken place, the basin will conform to the section as shown in the plans.

**212.03.04 Planting.** Do not plant any area until receiving written approval that the area concerned has been satisfactorily prepared.

Submit a schedule for plant installation for approval. Submit a monthly summary of completed plant installation.

In mixed planting areas, plant trees first, then follow with larger shrubs, low shrubs, and ground covers last.

Do not distribute more plants in the project area on any one day than can be planted and watered on that day.

Planting done in soil that is too wet, too dry, or not properly conditioned as provided herein will not be accepted. Planting work shall be suspended until the soil is satisfactory.

Gently remove plants from the container and loosen compacted roots. Place plant in the hole. Set plants upright, plumb, and faced to give the best appearance or relationship to each other or adjacent structure. Orient plant graft unions to face north. Trees shall stand vertical prior to staking. Set plants so that each plant bears the same relation to soil level when planted as it did when in container or with root crown or flare 10% above finished grade. Place each plant in the center of the plant pit.

Handle canned, boxed, and ball and burlap plants by container, root ball, or wire basket only. Use straps or hooks connected to container, root ball, or wire basket to lower trees into hole. Do not allow metal objects from construction equipment to come in contact with tree trunks at any time. Set and plumb tree first, then using bolt cutters and utility knife, remove wire basket and burlap. Maintain intact root ball.

Do not plant materials if the root ball is broken or cracked either before or during the process of planting. Once set, the root ball shall be scored to a depth of 25 mm (1 in.) to prevent circling roots.

Do not use frozen or muddy mixtures for backfilling. Tamp soil at 50% total backfill depth and water before adding more soil. Bring plant pit to grade with soil mix and form a water basin 100 mm (4 in.) in height of soil around the edge of each planting pit to retain water. Tree water basins shall be 1 m (3 ft) in diameter. Shrub water basins shall be 0.3 m (1 ft) in diameter. Grade basins so that water collects at the edge of the basin. Water soil within water basin and fill all voids.

Cover basin with wood chip mulch as shown and specified. Keep bark 100 mm (4 in.) away from trunk. Do not cover trunk collar with mulch.

Furnish and install paper tree wrap on all deciduous trees and wrap from trunk collar to first branch if showing sun or trunk damage.

Plants that show signs of failure to grow normally or which are so injured or damaged as to render them unsuitable for the purpose intended will be rejected. Immediately remove and replace rejected plants with approved plants.

Apply pre-emergent herbicide to all areas after planting is completed.

(a) Plants (Group A). Remove nursery stakes supporting plants in containers and properly prune the plants as specified herein.

Cut containers, at least twice, from top to bottom with a “cancutter” or other approved device. A spade or shovel is not an acceptable device. Remove the plants from the containers in such a manner that the ball of earth surrounding the roots is not broken. Plant and water immediately after removal from the containers. Do not cut containers before delivery of the plants to the planting areas.

(b) Plants (Group B). On balled and burlapped material, cut strings or cords and lay the burlap back from the top half of the ball. Perform this after the plant is placed in its final position and before completion of the backfill. Remove as much of burlap as possible while keeping root ball intact and cut away remainder of burlap. Burlap shall not be exposed above finished grade.

(c) Plants (Group C). As soon as each plant is removed from its container, plant it in the prepared planting bed, in a hole previously prepared with a broad, blunt end trowel. Carefully lift the plant with the trowel, insert in the hole, and gently firm the earth around it to eliminate air pockets. Tap plants loose from pots in such a manner that the ball of earth surrounding the roots is not broken, and then immediately plant. Plants in peat pots may be planted in the pots, provided the peat fiber is thoroughly wet. Plants brought to the jobsite in flats, pony packs, or bare root will not be accepted. Keep roots of plants moist and covered at all times and do not expose to the air except while actually being placed in the ground. Set plants in a plumb position in the backfill mixture material to such a depth that, after the soil has settled, the top of the plant ball will be level with the finished grade. Place plants in such a manner that the roots will not be restricted or distorted. Do not compact soil around the roots or ball of the plant during or after planting operations. Plants which have settled shall be raised to the required level.

Water plants immediately after planting.

**212.03.05 Staking and Guying.** Perform staking and guying concurrently with the planting operation.

Fabricate stakes from cedar, redwood, lodgepole pine, or as approved.

(a) Staking. Stake the plants specified in the contract documents.

The size, number of stakes, and the depth to be driven shall be as specified in the contract documents.

Preset stakes in empty holes using two 50 mm (2 in.) diameter stakes. Place the stakes vertically 0.3 m (1 ft) from the tree, and at least 450 mm (18 in.) into native soil below bottom of plant pit in the case of Plants (Groups A and B). For deciduous trees, stake top shall be 0.3 m (1 ft) below lower tree branches after tree is planted. Place stakes at right angles to prevailing winds.

(b) Tree Ties. Provide firm connections for attaching the ties to stakes and trees as shown on the plans. The tree shall be supported to assure a straight, firm position while being allowed to sway slightly from side to side. Ties shall be placed so that they will not girdle, scar, or damage the bark on the trunk.

(c) Guying. Guy evergreen trees larger than 3 m (10 ft) in height and deciduous trees larger than 75 mm (3 in.) in caliper as shown on the plans.

Use three No. 19 (# 6) rebar stakes, 450 mm (18 in.) in length. Place stakes a minimum of 0.3 m (1 ft) outside of the planting pit and such that guy wires will be angled at a 45 degree angle away from the tree. Evenly space stakes around the tree and drive 0.3 m (1 ft) into the ground.

Use No. 9 minimum diameter, twisted, galvanized guy wire with a protective collar of rubber or vinyl hose of sufficient length so the wire does not come into contact with or gouge tree bark. While the tree is lying down, preassemble the guy wire into the protective collar and use 25 mm (1 in.) diameter U shaped bolts to clamp wire at tree. Pass the protective collar around the trunk so that it rests in the cleft of the lowest main branches of the tree. Place U bolt a minimum of 150 mm (6 in.) away from tree trunk with 0.3 m (1 ft) minimum of extra guy wire past the U bolts at the tree. Place tree in vertical position in pit. Arrange the guys so they hang free and evenly spaced around the tree and clear of other branches. Extend the guy wire 75 mm (3 in.) minimum below the top of the stake and wrap the extra wire 2 times around the stake, through a second U bolt and tighten. Adjust tree once all guy wires are installed to ensure vertical plumb position.

**212.03.06 Pruning.** Perform pruning as directed before plant materials are brought to the jobsite and planting areas. Do not prune evergreen coniferous plants except as directed. Perform removal of dead leaves from ground cover plants before these plants are brought to the planting areas.

While retaining natural growth shape characteristics of species, remove all damaged branches after planting. Do not remove or cut central leader. Prune according to Standard of the National Arborists Association. Exercise extreme caution while pruning trees to prevent spread of vascular diseases. Dip pruning tools in sterilizing agent before beginning pruning and before moving from one tree to another.

**212.03.07 Watering.** If water is available from a new or existing State-owned irrigation system within the limits of the project, it may be obtained from such system free of charge. Where water is not available from such State-owned facility, furnish and apply water and pay all costs involved. Keep valves at meters closed at all times, except while the irrigation system is actually in use. Prevent water from wetting vehicles, pedestrians, and pavement. Repair any erosion, slippage, or settlement of the soil caused by watering.

Water shall be free of oil, acid, salts or other substances which are harmful to plants. The source shall be as approved prior to use.

Water all existing and proposed plants during construction to keep plants in a healthy, thriving condition.

(a) Plants (Groups A and B). Water plants immediately after planting. Apply water until the backfill soil around and below the roots or ball, or earth around each plant, is thoroughly saturated. Where watering is done with a hose, use an approved metal or plastic pressure reducing device. Do not allow the full force of the water from the open end of a hose to fall within the basin around any plant. After the first watering, apply water to all plants as often and in sufficient amount as conditions may require to keep the soil wet around the root systems of the plants during the life of the contract. After the installed irrigation system has been accepted, it may be used to water the planted area. Furnish additional watering measures required to initially saturate the backfill. Maintain the plants in a satisfactory growing condition.

(b) Plants (Group C). As soon as all the plants in a given area have been planted, apply water to that area in a fine mist from an atomizing nozzle until the entire planting bed is saturated. Do not perform this initial watering with the installed irrigation system. After the first watering, apply water to the areas as often and in sufficient amount as conditions may require to keep the soil moist around the root systems of the plants during the life of the contract.

**212.03.08 Fertilizers and Additives.** When fertilizers or additives are called for, apply them at the rates and as specified in the contract documents.

**212.03.09 Plant Establishment Work.** This work consists of replacement of plants, fertilizing, pruning, edging, mulching, weeding, trash removal, and watering all of the landscape areas, plant materials, and seeded or hydro-seeded areas in a vigorous and healthy condition in accordance with generally accepted horticultural practices and general maintenance as specified herein.

The plant establishment period will begin at such time as all landscaping, planting, and seeding operations have been accomplished, all other work has been completed, and the project is in a neat and clean condition.

The Engineer may establish separate dates for the start of the plant establishment periods based on acceptance of portions of the landscape installation.

The plant establishment period shall run from the beginning date established by the Engineer for a period of one year.

Submit a schedule of plant establishment activities, manpower, and equipment for approval before starting establishment activities. Provide monthly, a summary of plant establishment activities completed, including man hours expended.

Notification will be given in writing of the start of the plant establishment period and statements will be furnished regarding days credited to the plant establishment period after said notification.

Failure on any day to adequately perform required plant establishment work will not be credited as one of the plant establishment days. No extension of contract time will be granted beyond the final completion date by reason of failing to perform plant establishment work on days when such work is necessary.

All plants and seeded or hydro-seeded areas shall be watered regularly, as needed, through the end of the plant establishment period using clean potable water from a portable or temporary source to hand apply water to plants. Individually water all plants avoiding over-spray and erosion onto adjacent mulched areas.

Keep all plants watered as provided in Subsection 212.03.07. Make irrigation adjustments as directed.

Prune or head back trees and shrubs when directed. Use pruning standards accepted by the International Society of Arboriculture or the National Arborist Association.

Remove and replace in kind all plants that show signs of failure to grow normally or which are so injured or damaged as to render them unsuitable for the purpose intended, as directed. Work will be inspected on the first or second working day of each week during the plant establishment period, and all plants to be replaced will be marked or otherwise indicated. Complete replacement of such plants within 2 weeks of notification. Use plants pre-approved for replacements.

Maintain the entire area within the project limits free of weeds. Implement the noxious weed abatement plan which conforms to the Nevada Revised Statute (NRS 555). Do not allow any noxious weeds and/or Cheatgrass (Bromus tectorum), Russian Thistle or Tumbleweed (Salsola sp.) and Tall Whitetop (Lepidium sp.) to flower or set seed within the project area. Remove weeds by hand or with herbicides approved for use on the QPL and apply according to the manufacturer's directions. The only vegetation to remain shall be seeded or planted material and existing native vegetation identified to remain.

Maintain water basins, rake rivulets and gullies, check trees for vertical alignment, adjust or replace stakes, guys, bracing, and ties as necessary.

Spray or dust with appropriate insecticides, miticides, and fungicides as necessary to maintain plants in healthy and vigorous growing condition. Have pest, disease, and weed control chemicals applied according to their manufacturer's instructions by licensed applicators and as required by authorities having jurisdiction over such activity.

Remove and dispose of surplus earth, papers, trash, and debris, which accumulate in the planted areas according to Subsection 107.14. Care for the planted areas as to present a neat and clean condition at all times.

Remove the staking & guys for plants as directed at the end of the plant establishment period.

Liquidated damages will be assessed for each day the plant establishment work is inadequately performed. See Subsection 108.09 of the Special Provisions.

## METHOD OF MEASUREMENT

**212.04.01 Measurement.** Preparing soil will be measured by the square meter (square foot).

Header boards will be measured by the linear meter (linear foot).

Plants and planter boxes will be measured by the each.

Plant establishment work will be measured by the lump sum.

## BASIS OF PAYMENT

**212.05.01 Payment.** The accepted quantities, measured as provided above, will be paid for at the contract price per unit of measurement for the pay items listed below that are shown in the proposal. Payment will be full compensation for the work prescribed in this Section.

Payment will be made under:

| Pay Item | Pay Unit |
|---|---|
| Preparing Soil (type) | Square Meter (Square Foot) |
| Planter Boxes (type, size) | Each |
| Header Boards | Linear Meter (Linear Foot) |
| Plants (group) | Each |
| Plant Establishment Work | Lump Sum |

# SECTION 213

## IRRIGATION SYSTEMS

DESCRIPTION

**213.01.01 General.** This work consists of furnishing and installing irrigation systems.

**213.01.02 Submittals.** Within 30 days after award of contract, submit 3 sets of three ring binders, with brochures or shop drawings for each accessory or fixture, and clearly identify each item of hardware or equipment to be installed, before ordering.

The submittal shall include the manufacturer installation instructions for all equipment and materials used with pertinent dimensions, finish, proper placement, operation, maintenance data, and MSDS.

If approved, one stamped three ring binder will be returned to the Contractor. Do not install equipment or materials until given approval.

MATERIALS

**213.02.01 General.** Material shall conform to the following Section:

Roadside Materials ..... Section 726

Portland cement concrete shall be Class A or Class AA unless otherwise provided, and shall conform to Section 501.

**213.02.02 Bedding and Backfilling.** Backfill polyvinyl chloride (PVC) pipe to be used as conduit for future irrigation systems with native soil backfill which has been screened to remove rocks that are 12.5 mm (1/2 in.) or larger. Bed and backfill PVC pipe supply lines as shown on the plans. Material for sand bedding of pipe supply lines shall conform to the sieve size requirements for fine aggregate specified in Subsection 706.03.03.

**213.02.03 Automatic Controllers.** Controllers shall be coordinated to tie into Department adopted central irrigation control system located at District headquarters or function as stand alone systems compatible with Department adopted central irrigation control system. Controllers shall be an electrically timed device for automatically opening and closing control valves for predetermined periods of time and mounted so that all normal adjustments will be conveniently located for use by the operator. The controller shall be programmable for irrigation schedule including the time of day, the number of watering times per week, and the length of time each valve operates. When called for on the plans, controller installation shall include sensors to detect changes in soil, wind, and precipitation conditions. Enclose controllers in a weatherproof steel housing with hasp and lock or locking device. Master key locks or locking devices and provide 3 sets of keys.

Equip the controller to adjustably operate each valve in the circuit for setting to remain open for any desired period of time from 1 minute to 4 hours to provide adequate watering within an approved water window.

The controllers shall require a communication link for connection to a central control computer.

Equip the controller to operate on 110 - 117 V and with a circuit breaker or fusible connection to protect the controller from overloads.

Provide the controller with a master on-off switch to turn all stations off without disturbing the clock settings or automatic timing sequences.

Provide controls to allow any position to be operated manually both on and off whenever desired.

Provide controls for resetting the start of the irrigation cycle at any time and advancing from one position to another.

Irrigation control conductors shall be copper, UL approved, type UF direct burial cable of the gage indicated in the contract documents. Make splices in direct burial cable with a UL approved kit for that purpose and install in a traffic rated valve box.

The controller shall have a solid state design and have random access of all stations.

The controller shall have a built-in output surge protection and lightning protection grounding.

Automatic controller units shall be pre-assembled by the manufacturer's representative and include grounding, wiring, footing, and other appurtenances to construct a complete operable assembly.

Installation of the controller systems shall include a flow meter assembly and a 14 gauge wire between the flow meter and controllers in a 25 mm (1 in.) electrical polyvinyl chloride conduit placed in same trench as the mainline.

The controller shall have the ability to upgrade to radio remote capability up to a distance of 610 m (2,000 ft).

Units to have programming password and stainless steel lock securing weather resistant exterior panel.

**213.02.04 Booster Pump.** Use electric powered pump to meet system needs of volume and pressure for irrigation valve with the highest flow and pressure demand and as indicated on plans. Discharge pressures in kPa (psi) and flows in liters per minute (gallons per minute) minimum and maximum shall be met before installation occurs. Pump shall have an e-coat cast iron casing, motor adapter, stay bolts, stainless steel impellers and pump shaft. Pump shall be placed in locking vandal resistant enclosure. Power shall be single or triple phase and minimum 60 Hz. Pump shall include all necessary equipment per manufacturer.

**213.02.05 Thrust Blocks.** Construct thrust blocks of the size and at the locations shown. Place thrust blocks against undisturbed soil.

Wrap pipe and fittings which contact thrust block with 200 µm (8 mil) minimum thickness polyethylene wrap as a bond breaker. Use No. 13 (# 4) reinforcing steel conforming to Section 505 for joint restraints around pipe and anchor in thrust blocks.

**213.02.06 Sprinkler Heads.** Supply sprinkler heads of the type, pattern, and coverage shown on the plans. Sprinkler heads shall be placed to provide head to head coverage and shall have matched precipitation rate nozzles unless otherwise specified.

**213.02.07 Drip Emitter Assembly.** Drip emitters shall be pressure compensating, self-flushing, and have 1 or 2 gallon per hour flow rate at 140 kPa (20 psi) minimum to 210 kPa (30 psi) maximum, with a barbed connector. The flow rate shall be independent of temperature as to sun or shade, night or day. Use rigid schedule 40 PVC pipe for supply (lateral) lines to center of drip area limits and polyethylene drip tubing to the emitter. The emitter assembly shall include drip emitters, a barb by barb connector, and 6 mm (1/4 in.) drip distribution tubing.

**213.02.08 Valve Protection Sleeves.** Use precast reinforced Portland cement concrete sleeve valve protectors with a cast-iron lid of the dimensions shown. Extend valve protectors as necessary to reach the depth indicated. Make extensions of the same materials as the valve protectors. Valve protectors and extensions may be the product of commercial producers upon prior approval.

In lieu of the concrete valve protectors, fiberglass or plastic valve protectors may be installed, providing they meet the requirements of ASTM D256, D638, D648, and D790.

**213.02.09 Gate Valves.** Valves 2 1/2-NPS and smaller shall be of the same size as the pipes on which they are placed unless otherwise indicated on the plans. Service rating for non-shock cold water shall be 1,380 kPa (200 psi). These valves shall be all bronze, with rising stem and union bonnet. Provide valves with a gland to compress packing, and with back seating to permit repacking the valve under full pressure when it is wide open. Valves shall have cross type handles of brass. Thread and install valves 2 1/2-NPS and smaller with one union on either side of the valve.

Gate valves 3-NPS and larger, shall be iron body, bronze mounted, double disc, parallel seat type with "O" ring seal, and shall comply with AWWA Standards. These valves shall have a working pressure of 1,380 kPa (200 psi) and a test pressure of 2,760 kPa (400 psi). Furnish a shut-off rod, 1.8 m (6 ft) in length that will fit a 50 mm (2 in.) wrench nut.

Do not mount gate valves on swing joints.

**213.02.10 Control Valves.** Manual control valves shall be straight or angle pattern globe valves of all brass or bronze construction with replaceable compression disks. Control valves shall be of the same size as the pipes on which they are placed unless otherwise indicated on the plans, and provide with a union connection. Provide manual control valves capable of withstanding a cold water working pressure of 1,030 kPa (150 psi).

Master electric control valves shall be of the diaphragm type, normally open, 24V, 60 cycle.

Electric control valves shall be of the diaphragm type, normally closed, 24 V, 60 cycle. The valve solenoids shall operate with 18 to 30 V of power. Completely encapsulate the solenoid for positive waterproofing. Provide the valve body and bonnet of cast brass or bronze, flange or threaded type. Provide threaded type with a union connection. The time interval between opening and closing the valve shall not be less than 5 seconds. Spring load the solenoid plunger so the valve may operate when installed in any position. Construct the solenoid plunger of stainless steel with a neoprene seat. Provide valve bonnet with a bleed screw for manual operation and a manual flow control adjustment. Electric control valves shall be capable of withstanding a non-shock cold water working pressure of 1,030 kPa (150 psi).

The drip irrigation control unit shall consist of a 1-NPS, bronze or brass construction valve and pressure regulating device to reduce water pressure to the level for which drip emitters are rated. The pressure regulating device shall have an adjustable reduced pressure range of 100 kPa (15 psi) to 1030 kPa (150 psi) flow pressure, an integral strainer unit, and a pressure gauge with a range of zero to 690 kPa (100 psi) and the necessary fittings to conform to the diagrams shown on the plans. The assembly shall also include a basket filter with stainless steel screen. For areas with clay soil use 200 mesh stainless steel screen and for areas with sand soils use 100 mesh screen. Filters shall be capable of withstanding a cold water working pressure of 1030 kPa (150 psi).

**213.02.11 Quick Coupler Valves.** The quick coupler valve shall be of brass or bronze, 2 piece construction with removable upper body. Design the valve body with a single slot to receive a single slot coupler. The top shall have a locking rubber cover. Provide three each cover key and valve keys with hose swivels.

**213.02.12 Valve Boxes.** Use reinforced precast Portland cement concrete valve boxes with a steel lid. Size valve boxes to provide 150 mm (6 in.) minimum clearance around entire equipment assembly. Provide Portland cement concrete footing under valve box as shown on Standard Plan Sheet T-30.1.18.

Provide valve boxes with extensions as necessary to reach the depth indicated. Extensions shall be of the same material as the valve box.

In lieu of concrete valve boxes, fiberglass or plastic valve boxes may be installed providing they meet the requirements of ASTM D256, D638, D648, and D790.

Use gravel in valve box installations conforming to Subsection 704.03.01 for Type 2.

Etch valve box lids, as well as on the interior recessed portion of the lid flange, with initials as appropriate for the box contents as shown below. Letter and number size shall be 25 to 100 mm (1 to 4 in.).

| Box Contents | Initials |
|---|---|
| Shut off valve | S.V. |
| Remote control sprinkler valves | S / controller letter / station number |
| Remote control drip valves | D / controller letter / station number |
| Quick coupling valves | Q.C. |
| Wire splices | W.S. |
| Drain valve | D.V. |
| Air relief valve | A.R.V. |
| Isolation valves (gate valves) | I.V. |
| Master control valve | M.C.V. |
| Flow sensor | F.S. |
| Drip lateral flush plug | F.P / control letter / station number |

**213.02.13 Irrigation Control Wiring.** Control wire shall be 14 gauge minimum for control, 12 gauge minimum for common wire. Wire gauge shall be adjusted per manufacturer's specifications for distance from controller to component. Use direct burial wire. Common wire shall be white.

**213.02.14 Chemigation Manifold.** Supply three 1/4-turn valves on outlet side of reduced pressure assembly between brass tee with plug and brass union. See reduced pressure assembly (RPA) detail. Size valves as shown on the plans.

**213.02.15 Drain Valves.** Construct automatic ball check valves of 12.5 mm (1/2 in.) threaded plastic with a closing pressure of 69 to 76 kPa (10 to 11 psi) and an opening pressure of 62 to 69 kPa (9 to 10 psi). The valve shall have a maximum working pressure of 6.9 MPa (1,000 psi) and a minimum bursting pressure of 17.2 MPa (2,500 psi).

Install valves with a washed gravel sump as shown on the plans. Use gravel conforming to the requirements for Size No.7 in Subsection 706.03.01.

Manual drains shall be bronze gate valves as shown on plans with cross top handle.

**213.02.16 Air Relief Valve.** Design the air relief valve to release air entrapped in a pipeline until liquid reaches the float which will rise to the seat and close the valve. The float shall be stainless steel resting within a stainless steel or bronze cup. The valve body and flange shall be brass/bronze construction. The valve shall be 1-NPS size with screwed inlet, and shall be capable of withstanding pressures up to 2,070 kPa (300 psi).

**213.02.17 Backflow Preventers.** Use reduced pressure principle type backflow preventers as required by the water purveyor.

Backflow preventer assemblies shall withstand a maximum operating pressure of 1,200 kPa (175 psi) and shall include the backflow preventer and appropriate valves on each end.

Valves 2 1/2-NPS and larger shall be flanged type, iron body, brass trimmed, resilient wedge with non-rising stem. Valves smaller than 2 1/2-NPS shall be full port resilient seated ball valves.

Provide the backflow preventer assemblies of the size shown on the plans. Provide backflow preventer assemblies smaller than 2 1/2-NPS with a union on each end of assembly.

Upon completion of installation, and before being put into service, have the backflow preventers tested by the water purveyor or a certified tester who was certified within the last 3 years by the AWWA. The testing equipment shall have been certified within the past 12 months. Test the backflow preventers again at the end of the one year plant establishment period. Provide proof of current certification for both the tester and testing equipment. Provide a written report of the test results.

Perform the tests according to the provisions of the Manual of Cross-Connection Control. The testing equipment shall have all necessary hoses and fittings and be equipped with a differential pressure gauge that has a differential range of at least zero to 100 kPa (15 psi) and graduations of not more than 1.5 kPa (0.2 psi).

Make necessary repairs only with the backflow preventer manufacturer approved parts.

The backflow preventer assembly shall also meet the requirements of the Water Purveyor, the American Society of Sanitary Engineers (ASSE), and the AWWA.

The backflow preventer shall be furnished with a cover that is pre-manufactured of marine grade aluminum alloy 5052-H32 conforming to ASTM B209 with a minimum wall thickness of 3 mm (0.125 in.). The main housing shall be of a solid sheet with a minimum R-6 rigid sheet insulation on the top and sides. Install a flexible rubber insert formed in a loop to provide dead air space along the bottom. The backflow preventer cover shall be vandal and weather resistant. The length of the cover shall be expandable to allow for site adjustment and shall be a center split design having mounting lips on each side. Submerge the mounting base into the concrete a minimum of 50 mm (2 in.), and position the cover 38 mm (1.5 in.) above the concrete for drainage purposes. The locking mechanism shall be flush mounted of the full release type which allows for complete removal of the cover from its mounting base without use of tools. Conceal the handle controlling the locking mechanism within the surface of the enclosure and provide padlock system. Take care to insure that the cover can be properly opened in all directions.

Manufacturers of backflow preventer covers are listed in the QPL.

## CONSTRUCTION

**213.03.01 General.** The irrigation system as shown on the plans is diagrammatic and may require modification so as to provide complete and adequate coverage of the areas to be irrigated. Do not willfully install the irrigation system as shown when it is obvious in the field that obstructions or differences in dimensions exist from that shown on the plans. Give immediate notification of obstructions or deficiencies.

Do not alter or change the location of pipes, valves, sprinklers, or other equipment as shown on the plans unless so authorized. Make necessary arrangements for connecting to mains with the agency supplying the water, with such installations and equipment conforming to the requirements set forth by the supplying agency.

The point of connection shall be as indicated on the plans.

Submit written documentation of available flow and pressure downstream from the point-of-connection after the meter prior to system installation. Give notification immediately if available flow and pressure is less than required to operate the system as designed. Do not begin installation of the system until necessary design revisions have been made.

Irrigation components shown within paved areas shall be installed in planting areas whenever possible. Provide equipment and parts not specifically noted but reasonably inferred from the plans and specifications.

Coordinate installation of irrigation components to avoid conflict with other trades and for placement of pipe, wiring, conduit, and irrigation components.

Stake out the location of each run of pipe and valve locations before trenching.

Components shall be adjusted to provide adequate water for thriving growth of plant material with minimal over spray of water onto adjacent surfaces.

Maintain the operation of existing irrigation systems to areas adjacent to the project site during construction with uninterrupted water service.

Provide an installation schedule to allow the Department or water purveyor to inspect all aspects of irrigation installation. Uncover, expose, or retest elements installed without prior notification.

**213.03.02 Excavation.** Make trenches of sufficient width to permit placing of pipe. Do not snake pipe connected with rubber ring-type fittings. Keep the top 150 mm (6 in.) of top soil, when such exists, separate from subsoil and replace as the top layer when backfill is made.

Excavate trenches in rock or like material 50 mm (2 in.) below the required depth and backfill to the required depth with sand or other suitable material free from rock or stones.

Exercise care when excavating trenches near existing trees. Where roots are 50 mm (2 in.) and greater in diameter, except in the direct path of the pipe, hand excavate and tunnel the pipe trench. Wrap large exposed roots with heavy burlap or canvas for protection and to prevent excessive drying. In trenches dug by machines adjacent to trees having roots 50 mm (2 in.) and less in diameter, hand trim sides making a clean cut of the roots. Backfill trenches having exposed tree roots within 24 hours unless adequately protected by moist burlap or canvas. Keep burlap or canvas moist until trench is backfilled. Remove burlap or canvas immediately prior to backfilling trench.

**213.03.03 Piping.** Install live main lines a minimum of 900 mm (36 in.) below finished grade, measured from the top of the pipe. Install lateral PVC secondary supply lines a minimum of 450 mm (18 in.) and drip lateral and distribution lines a minimum of 150 mm (6 in.) below finished grade, measured from the top of the pipe. Provide 75 mm (3 in.) clear to pipe, connections, and fittings.

Provide water lines installed less than 900 mm (36 in.) below finished grade, except drip lines, a means for drainage to prevent freezing. Slope pipes to drain without sags. Unless otherwise specified, place drain valves only at the low point of all lateral PVC or main lines.

Place live mains and wiring located under pavement in separate PVC sleeves, placed adjacent and parallel. Sleeves shall be sized 50 mm (2 in.) in diameter larger than the size of the pipe to be extended thru the sleeve and shall be made of Schedule 40 PVC pipe, unless noted otherwise on the plans. Add extra sleeves as shown on plans. Extend sleeves a minimum of 0.6 m (2 ft) beyond the edge of the paved surface, cap sleeves and mark surface with location marker for future access. Spray paint location marker with orange paint. Sleeves for drip tubing shall be installed 200 mm (8 in.) below finished paved surfaces. Bore under existing to place sleeves, unless otherwise noted on the plans. Perform boring operations in an approved manner and run conduit at a depth below the pavement as specified. Lines and wiring shall be installed under paving in separate conduit. Where possible, place mains, laterals, and drip lines in the same trench.

For contracts located in some areas of southern Nevada, the minimum required depth for the installation of live main lines of 900 mm (36 in.) below finished grade and the requirement to provide a means of drainage of water lines installed less than 900 mm (36 in.) below finished grade, as stated above, may be reduced to 600 mm (24 in.) when approved in writing. Make requests for approval, in writing, according to Subsection 102.05.

**213.03.04 Jointing.** Install galvanized steel pipe with sound, clean cut well fitted standard pipe threads. Well ream pipe to the full diameter and remove burrs before assembly. Smoothly and evenly apply joint compound to the male thread only on threaded joints. Use joint compounds listed in the QPL. Make screwed joints tight with tongs and wrenches without the use of handle extensions. Clean and remake joints that leak with new material. Do not caulk or use thread cement to make joints tight.

**213.03.05 Installation.** Install conduit not less than 450 mm (1.5 ft) below the curb grade in sidewalk areas and not less than 1,070 mm (3.5 ft) below the finished grade in all other areas. Install conduit under existing pavement by approved boring or drilling methods. Do not disturb pavement without approval, and only in the event obstructions are encountered. When permitted, small test holes may be cut in the pavement to locate obstructions. Keep boring or drilling pits at least 600 mm (2 ft) from pavement edge wherever possible. Do not excessively use water that will soften sub-grade or undermine the pavement.

Excavation shall conform to the construction provisions in Section 206. Backfill shall conform to Section 207, except backfill materials shall not exceed 12.5 mm (1/2 in.) in largest dimension. Grade and prepare the bottom of the trench to provide a firm and uniform bearing throughout the entire length of the conduit. During backfilling operations, rigidly support the conduit so that no movement of or damage to the conduit or joints will result.

Where connection is made to existing supply lines, compression type fittings may be used with approval.

Install a backflow preventer at each meter if called for on the plans.

Where supply lines or conduits are to be installed through existing paved areas, remove the sub base, base, and paving and replace with material of equal quality.

Cut pipe straight and true. After cutting, ream out the ends to the full inside diameter of the pipe.

Place irrigation main lines from meter to manual drain after backflow preventer assembly in a trench of 150 mm (6 in.) minimum width and lay on a 50 mm (2 in.) layer of sand bedding as shown on the plans. Snake irrigation pipe from side to side in the trench at approximately 7.5 m (25 ft) intervals. Partially backfill PVC pipe between joints with smaller amounts of backfill material to prevent movement during the pressure test. Threaded pipe components shall be joined with four turns of PTFE (thread seal) tape.

Install and lay drip tubing according to the manufacturer's recommendations. Use barb connectors to connect tubing together. Construct drip emitter assembly as shown on the plans. Install emitters directly uphill of plant when planting on slopes.

Fit the stub ends of drip tubing with an approved flushing end plug which will facilitate future draining or flushing.

Prevent foreign material from entering the irrigation system during installation. Immediately before assembling, clean pipes, valves, and fittings. Plug or cap unattached ends of pipe, fittings, and valves pending attachment of additional pipe or fittings. Thoroughly flush lines out before attachment of terminal fittings.

Install sprinkler connections on swing joints or swing piping as detailed on the plans.

Locate automatic drain valves at system low points a minimum of one valve per lateral. Locate manual drain valves in main line at all low points a minimum of 1 per 30 linear meters (100 linear feet).

Install and lay PVC irrigation pipe according to the manufacturer's instructions. Before joints of PVC plastic pipe are made up, expose the plastic pipe fittings to the same temperature for a reasonable length of time. Cut pipe with a fine-tooth hacksaw or PVC cutters and remove burrs. Clean and soften the outside surface of the pipe and the inside surface of the fittings with an approved primer, using a dauber, brush top applicator, or paint brush about half the pipe diameter. Apply a light second coat of primer to the fitting socket. Do not allow primer to run down the inside of the pipe.

Using an approved cement, apply the cement solution to the pipe and fitting socket with an applicator having a width of approximately half the diameter of the pipe, using the proper cement for the size of pipe. Apply a full, even layer of cement on the pipe, equal to the depth of socket. Flow the cement on with the applicator, do not brush it out to a thin paint type layer. Apply a medium layer of cement to the fitting socket, avoid puddling cement in the socket. On bell end pipe, do not coat beyond the socket depth or allow cement to run down in the pipe beyond the bell. Apply a second full even layer of cement on the pipe. Assemble the pipe and fitting without delay, making certain cement is wet. Use sufficient force to ensure that the pipe bottoms in the fitting socket. Twist the pipe 1/8 to 1/4 turn as it is inserted. Hold the fitting and the pipe together until cement takes its initial set. After assembly, the joint shall have a ring or bead of cement completely around the junction of the pipe and fitting. If voids in this ring are present, it indicates sufficient cement was not applied and the joint will be considered defective. Using a rag, remove the excess cement from the pipe and fitting including the ring or bead. Avoid disturbing or moving the joint. Handle newly assembled joints carefully until initial set has taken place. The setting time allowed before handling or moving is related to temperature, type of cement, and size of pipe, and shall be according to manufacturer's recommendations. Do not use old or thickened cement.

Thrust blocks shall be provided at each valve, bend, tee, plug, dead end, and at reducers or fittings where changes occur in pipe diameter or direction. Pour thrust block so access to flanges and bolts is not obstructed.

**213.03.06 Copper Installation.** Threaded pipe connections shall be installed with 3 to 4 wraps of PTFE (thread seal) tape.

Slip pipe connections are to be soldered. Clean pipe ends with a scratch cloth or steel wool until both sides of the couplings and pipe are shiny clean, apply flux, join, and solder.

**213.03.07 Drip Irrigation.** Drip irrigation zones shall be a maximum length of 60 m (200 ft) for 12.5 mm (1/2 in.) drip irrigation line and 120 m (400 ft) for 19 mm (3/4 in.) drip irrigation line, each being controlled by a separate valve. See details for drip valve/pressure reducer/filter configuration. The general distribution of drip irrigation water shall occur through PVC laterals. Shrub and tree plantings shall be provided with drip irrigation. Where multiple emitters are indicated in the schedule, place at equal locations around each plant.

**213.03.08 Flow Sensor.** See Point of Connection Detail for installation sequence. Sensors shall be sized for flow rather than pipe size. Install flow sensor and controller connection according to manufacturer's recommendations and as shown on the plans.

**213.03.09 Irrigation Control Wiring.** Control wire shall be placed loosely beneath pipes in the trench and taped at 4.5 m (15 ft) intervals. Provide pull box or junction box at locations where wire is spliced and at controller. Place one extra length of wire with the wires in the longest electrical circuit.

**213.03.10 Flushing and Testing.** Flush supply lines completely of foreign particles before placing section control valves, quick-coupler valves, and hose bibs. After flushing and when valves are in place, test supply lines at the maximum available pressure with valves closed. Maintain pressure for a period of not less than 4 consecutive hours. Clean, remake, and retest joints showing leaks.

After inspection and before backfilling, run water through the entire line until the pipe has been cooled to the lowest temperature, then immediately backfill the trench in a manner that no damage or disturbance is caused to the pipe.

After installation of section lines, completely flush the piping of foreign particles before attaching sprinkler heads and drain valves. After flushing, test section lines with risers capped and drain valves closed. Make the test at maximum operating pressure for a period of one hour. Clean, remake, and retest joints showing leaks.

Test control tubing in the manner specified for main supply lines. Flush tubing for 5 minutes before connection with the control valves.

Test automatic controllers by actual operation for 2 weeks under normal operating conditions. Should adjustments be required, do so according to manufacturer's direction and test until operation is satisfactory.

Test booster pump with the casing full of water and primed. Pump shall be placed along the pressurized mainline and after the reduced pressure assembly unless otherwise noted on plans and details.

**213.03.11 Backfill.** Do not start backfilling until all piping has been inspected, tested, and approved. Complete backfilling as soon as possible.

In trenches, place native soil, free from rock or stones larger than 12.5 mm (1/2 in.) in diameter. Place backfill from the bottom of the trench to approximately 150 mm (6 in.) above the pipe by continuous tamping in such a manner that will not damage pipe and proceed evenly on both sides of the pipe. Thoroughly tamp the remainder of the backfill. Do not use heavy equipment within 450 mm (18 in.) of pipe. Use backfill material free of rocks, roots, or other objectionable material. Construct the top 150 mm (6 in.) of the backfill of top soil material or the first 150 mm (6 in.) of material removed in the excavation.

**213.03.12 Adjusting System.** Before final inspection, adjust and balance sprinklers to provide adequate and uniform coverage. Balance spray patterns by adjusting individual sprinkler heads with the adjustment screws or replacing nozzles to produce a uniform pattern. Unless otherwise specified, prevent sprinkler spray patterns on pavement, walks, or structures.

## METHOD OF MEASUREMENT

**213.04.01 Measurement.** The materials to be measured for payment will be listed in the contract items by size, class, type, thickness, or whatever information is necessary for identification.

Pipe and tubing will be measured by the linear meter (linear foot). Pipe bends, wyes, tees, and other branches will be measured as pipe along center lines to the point of intersection.

Automatic controllers, booster pumps, chemigation manifolds, quick couplers, valve boxes, flow sensors, backflow preventers, backflow preventer covers, valve assemblies, riser assemblies, and drip emitter assemblies will be measured by the each.

Backflow preventer assemblies shall include the backflow preventer, pressure regulation device (per water purveyor requirements), valves, drains, chemigation inlets, unions, and fittings required for proper installation.

## BASIS OF PAYMENT

**213.05.01 Payment.** The accepted quantities, measured as specified above, will be paid for at the contract price per unit of measurement for the pay items listed below that are shown in the proposal. Payment will be full compensation for the work prescribed in this Section.

Payment will be made under:

| Pay Item | Pay Unit |
|---|---|
| (size) (type) Pipe | Linear Meter (Linear Foot) |
| (size) (type) (name of attachment) | Each |

# SECTION 214

## MAILBOX SYSTEMS

### DESCRIPTION

**214.01.01 General.** This work consists of furnishing and installing mailbox systems.

### MATERIALS

**214.02.01 General.** Furnish mailboxes which are marked by U.S. Postal Service and equivalent to the sizes removed (Standard or Large), including proper address labeling.

The mailbox systems shall include the mailboxes and mailbox support systems. The mailbox support systems shall be either Type A, B, or C as shown in the plans. The Type C mailbox support shown on Standard Plan Sheet R-12.1.3 shall be from the manufacturers listed in the QPL.

The mailbox support systems shall include all posts, brackets, hardware and any other incidentals required to install the completed systems. The required number of installations and types of mounts (single, double, and multiple) will be as indicated on the plans.

Equip the mailbox support system posts with a strip of 75 mm x 200 mm (3 in. x 8 in.) white reflective sheeting facing oncoming traffic as shown on the plans. The reflective sheeting shall conform to Subsection 716.03.01 for Type IV, IX, or XI.

### CONSTRUCTION

**214.03.01 General.** Install the mailbox systems according to the details shown on the plans and per the manufacturer's recommendations.

See Subsection 108.04 regarding limitations on the removal of existing and installation of mailboxes.

Before installing mailbox systems, give the U.S. Postal Service a minimum of 5 working days written notification so they can arrange their schedule to have a representative present to coordinate the installation of the mailbox systems.

### METHOD OF MEASUREMENT

**214.04.01 Measurement.** Mailbox systems will be measured by the each. The each measurement will be by the number of mailbox systems installed, regardless of the number, size and type of mailboxes attached thereto.

### BASIS OF PAYMENT

**214.05.01 Payment.** The accepted quantities, measured as provided above, will be paid for at the contract price per unit of measurement for the pay items listed below that are shown in the proposal. Payment will be full compensation for the work prescribed in this Section.

Payment will be made under:

| Pay Item | Pay Unit |
|---|---|
| Mailbox System (Single) | Each |
| Mailbox System (Double) | Each |
| Mailbox System (Multiple) | Each |

# SECTION 302

## AGGREGATE BASE COURSES

### DESCRIPTION

**302.01.01 General.** This work consists of constructing aggregate base courses on a prepared surface.

### MATERIALS

**302.02.01 General.** Material shall conform to the following Subsections:

| | |
|---|---|
| Type 1 Class A Aggregate Base | Subsection 704.03.02 |
| Type 2 Class A Aggregate Base | Subsection 704.03.04 |
| Type 3 Class A Aggregate Base | Subsection 704.03.06 |
| Type 1 Class B Aggregate Base | Subsection 704.03.03 |
| Type 2 Class B Aggregate Base | Subsection 704.03.05 |
| Type 3 Class B Aggregate Base | Subsection 704.03.07 |

### CONSTRUCTION

**302.03.01 Subgrade Preparation.** Correct and compact any ruts, holes, defects, or soft yielding places which occur in the subgrade or subbase to required density and stability before placing an aggregate base course thereon. Make the above mentioned repairs at own expense, except as provided for in Subsection 203.03.02.

**302.03.02 Spreading Class A Aggregates.** Spread the aggregate in one operation ready for compaction without further shaping except for trimming to correct minor deficiencies as hereinafter specified. Use a self-propelled spreader with a screed that strikes off and distributes the material to the required width and to the surface tolerances hereinafter set forth. The screed shall be adjustable to the required cross section and capable of spreading 3.6 m (12 ft) in width. Screed action includes any cutting, oscillating, or other practical motion that produces a finished surface texture of uniform appearance. Equipment not propelled by the unloading vehicle will be considered self-propelled. In narrow trench widenings, aggregate base course may be placed with self-propelled trench widening spreaders. If the spreader leaves ridges, indentations, or other objectionable marks that cannot be prevented by adjustments or eliminated by rolling, discontinue its use.

Equip the spreader with a control system which will automatically control the trimming of the base material to the specified transverse slope and established longitudinal grade. The control system shall be automatically actuated from an independent line and grade control reference through a system of electronically controlled mechanical sensors which will maintain the trimmer screed at the proper transverse slope and at the proper elevation to obtain the required surface. In case of failure of the control system, operate the trimmer by mechanical control only until the material on the roadbed at the time of breakdown is placed.

Motor graders will not be considered to be self-propelled mechanical spreaders unless they are equipped with end wings on the blade, have the blade locked in a position normal to the direction of travel, and are equipped with cross slope and automatic grade controls that are capable of picking up grade from a wire control, and from an external sensing wheel.

When motor graders are used, control the initial pass for final grade elevation by the wire line. Control subsequent passes by an electronic sensing device capable of maintaining grade.

Reference points will be established on one side of the roadway at reasonable intervals.

Furnish, place, maintain, remove, and dispose of all materials required to provide continuous line and grade control to the placing machine.

Aggregate bases, placed on road approaches and connections, street intersection areas, median strip areas, shoulder areas, and at locations which are inaccessible to the spreading equipment, may be spread in one or more layers by any means to obtain the specified results.

Other than previously provided in this Subsection, the use of motor graders will not be permitted during depositing, spreading and compacting operations, except as follows:

(a) Motor graders may be used to correct unavoidable segregation at edges and to trim the surface of the aggregate base after compaction in order to finish the base within the tolerances specified.

(b) When the area of the base is small or irregular, and it is impractical to use self-propelled spreading equipment, the base material may be spread by motor grader or other approved methods.

**302.03.03 Spreading Class B Aggregates.** Deposit the aggregate uniformly on the approved subgrade by means of the hauling vehicle with or without spreading devices. Thoroughly blade-mix the deposited base course material to full depth of the layer by alternately blading the entire layer to the center and back to the edges of the road. Spread and finish to the required cross section by means of a self-propelled pneumatic-tired motor grader.

The aggregate may be spread with a self-propelled spreader subject to the requirements of Subsections 302.03.02, and 302.03.04.

**302.03.04 Watering and Mixing Class A Aggregates.** Mix the base course material and water in a mixer. Add water during the mixing operation by means of spray bars in the amount necessary to provide the optimum moisture content for compacting. Transport after mixing to a uniform homogeneous appearance. Place the base material on the roadbed as provided for in Subsection 302.03.02. If the material has dried appreciably before final compacting, add additional water by means of a pressurized water truck to assist in compaction and to prevent raveling.

**302.03.05 Watering Class B Aggregates.** Apply water before and during all blading and processing operations to moisten the material sufficiently to prevent segregation of the fine and coarse particles. Apply water during the compaction and maintenance stages in sufficient amounts to assist in compaction and prevent raveling.

**302.03.06 Compaction.** Compact immediately following the spreading operation. Do not place the mixture in a layer exceeding 150 mm (6 in.) in compacted thickness. If vibratory compaction equipment is used, the compacted thickness of any one layer may be increased to 200 mm (8 in.). Aggregate bases, placed on road approaches and connections, street intersection areas, median strip areas, shoulder areas, and at locations which are inaccessible to the spreading equipment, may be spread in one or more layers by any means. Compact each layer to not less than 95% of the maximum density as determined by Test Method No. Nev. T108. The in-place density will be determined by Test Method No. Nev. T102 or T103.

Recompaction to the specified density may be required before placement of any subsequent course and no additional compensation will be allowed for such recompaction.

**302.03.07 Tolerance for Aggregate Base Courses.** When a 3.6 m (12 ft) straightedge is laid in any direction, the finished surface shall not deviate at any point more than 12 mm (0.04 ft) from the bottom thereof.

## METHOD OF MEASUREMENT

**302.04.01 Measurement.** Aggregate base will be measured by the cubic meter (cubic yard) or metric ton (ton).

The mass of material will be determined by deducting from the mass of material delivered to the work, the mass of water in excess of optimum plus one percentage point. Optimum moisture will be determined by Test Method No. Nev. T108. Moisture content will be determined by Test Method No. Nev. T112. The mass of water thus deducted will not be measured for payment.

## BASIS OF PAYMENT

**302.05.01 Payment.** The accepted quantities, measured as provided above, will be paid for at the contract price per unit of measurement for the pay items listed below that are shown in the proposal. Payment will be full compensation for the work prescribed in this Section.

Payment will be made under:

| Pay Item | Pay Unit |
|---|---|
| (type) Class A Aggregate Base | Cubic Meter (Cubic Yard), Metric Ton (Ton) |
| (type) Class B Aggregate Base | Cubic Meter (Cubic Yard), Metric Ton (Ton) |

# SECTION 304

## PORTLAND CEMENT TREATED BASE

### DESCRIPTION

**304.01.01 General.** This work consists of constructing one or more courses of a mixture of aggregate and Portland cement on a prepared surface.

### MATERIALS

**304.02.01 General.** Material shall conform to the following Sections and Subsections:

| | |
|---|---|
| Portland Cement | Section 701 |
| Cutback Asphalt | Subsection 703.03.03 |
| Emulsified Asphalt | Subsection 703.03.04 |
| Aggregate for Portland Cement Treated Base | Subsection 704.03.08 |
| Water | Section 722 |

Portland cement may be either Type I, Type IP “blended,” Type II, or Type V. The limitation on the amount of alkali in cements is hereby waived.

### CONSTRUCTION

**304.03.01 Proportioning.** Apply Portland cement to the mineral aggregate at a rate of 2% to 4.5% by mass of the dry mineral aggregate. Any allowable variations hereinafter set forth are to be inclusive of the above stated percentages. The exact rate of application of cement will be determined. The cement content will be determined by testing the fresh, moist cement aggregate mixture, by Test Method No. Nev. T239.

Add sufficient cement to provide a minimum compressive strength of 5.2 MPa (750 psi) at 7 days as determined by Test Method No. Nev. T236.

The method of mixing to be used, either plantmix or roadmix, shall be designated in the contract documents.

**304.03.02 Mixing—Roadmix Method.** (a) Depositing Untreated Aggregate. Deposit untreated aggregate on the prepared area by means of spreader boxes equipped with a readily adjustable strike-off device. Do not mix aggregate with roadbed material that is not to be treated.

(b) Mixing. Mix the components either on the roadbed or at a location off the roadbed by the roadmix method or the plantmix method.

For the plantmix method, all the requirements in Subsection 304.03.03, will apply, with the following exceptions:

1. The separation of aggregates into two sizes and storing in separate stockpiles will not be required.

2. The 0.4 of a percentage point variation in the cement content will be increased to 0.6 of a percentage point.

For the roadmix method, use an approved roadmixing machine of the pugmill, auger, or other type. Design the machine to pick up the material to be mixed from the windrow or blanket so that during at least 50% of the mixing cycle all the material is picked up and mixed while separated from the mixing table.

Furnish cement in bulk. Flatten or slightly trench the tops of windrowed aggregate to receive the cement. Distribute cement, by mechanical equipment, on the aggregate in a layer of uniform thickness. Calibrate each load in the spreading equipment so the average rate of spread can be determined. Do not vary the rate of cement spread per linear meter (linear foot) of windrow or blanket more than 10% from the designated rate. Spread the cement upon the aggregate an acceptable distance ahead of the roadmixing operations.

Use a roadmixing machine with provisions for introducing water at the time of mixing, through a metering device or by other approved methods. Apply the water by controls that will supply the approved quantity of water to produce a completed mixture with a uniform moisture content. Leakage of water from equipment will not be permitted.

Where the material is to be spread and compacted in two or more layers, mix material for each layer separately.

Mix the components with suitable equipment until a uniform mixture is obtained. If equipment is used that requires more than one pass of the mixer, make at least one pass before any water is added to the material.

At the time mixing is completed, the moisture content of the mixture shall not be in excess of 1% over optimum as determined by Test Method No. Nev. T236.

The cement content of samples from the product of the roadmixing machine, or from mixtures spread on the roadbed shall not vary above or below the required cement content of more than 0.6 of a percentage point based on the mass of the aggregate as determined by Test Method No. Nev. T239.

**304.03.03 Mixing—Plantmix Method.** (a) General. Mix the components at a central mixing plant by either batch mixing, using revolving blade or rotary drum mixers, or continuous mixing. Proportion the aggregate and cement either by mass or volume. Separate aggregates into two sizes and stockpile each size separately. One stockpile shall contain aggregate of which not more than 20% is finer than the 4.75 mm (No. 4) sieve. The other stockpile shall contain aggregate of which at least 80% is finer than the 4.75 mm (No. 4) sieve. If aggregates are separated into more than two sizes, combine approved sizes that will meet the grading and other test requirements.

Proportion water by mass or volume. Provide means by which to readily verify the amount of water per batch or the rate of flow for continuous mixing. The time of addition and the points at which water is introduced into the mixer, shall be as directed.

At the time mixing is completed, the moisture content of the mixture shall not exceed optimum as determined by Test Method No. Nev. T236.

Uniformly distribute cement throughout the aggregates during the mixing operation.

Completely mix all the material. Correct dead areas in the mixer, in which the material does not move or is not sufficiently agitated, by either a reduction in the volume of material or by other adjustment.

Proportion materials within the following tolerances:

| | |
|---|---|
| Aggregate masses or rate of feed | ± 5.0% |
| Cement content of the complete dry mixture | ± 0.4% |
| Moisture content of the completed mixture | ± 1.0% |

Furnish weighing equipment as specified in Subsection 109.01.

(b) Batch Mixing. Equip the mixer with a timing device which will indicate by a definite audible or visual signal the expiration of the mixing period. Use a timing device accurate to within 2 seconds. Equip the plant with a suitable automatic device for counting the number of batches.

Mix until a homogeneous mixture of uniformly distributed and properly coated aggregates of unchanging appearance is produced.

Weigh cement for each batch on scales separate and distinct from the aggregate batching scales.

If volumetric proportioning is used, provide means for accurately calibrating the amount of material in each measuring bin.

(c) Continuous Mixing. Draw the correct proportion of each aggregate size into the mixer by an approved type of feeder, which will continuously supply the correct amount of aggregate in proportion to the cement. Equip the plant with approved metering devices that will introduce the cement and water into the mixer in specified proportions. Interlock and synchronize the metering devices and feeder as to maintain a constant rate of cement, water, and aggregates in specified proportions. When storage bins are used, equip bins with overflow chutes for each compartment. Provide a positive signal system that will automatically close down the plant when the level of material in any bin approaches the strike-off capacity of the feed gate. Do not operate the plant unless the signal system is working. Use mechanically or electrically driven aggregate feeders. Directly connect aggregate feeders that are mechanically driven with the drive on the cement feeder. Equip the plant with satisfactory facilities for calibrating gate openings and metering devices by weighing check samples. Actuate aggregate feeders that are electrically driven from the same circuit that serves the motor driving the cement feeder.

Mix until a homogeneous mixture of uniformly distributed and properly coated aggregates of unchanging appearance is produced.

Equip the cement feeder with a positive weighing device.

**304.03.04 Spreading.** (a) General. Prepare and compact the surface to be covered with cement treated base to grade and cross section. Dispose any material cut away in trimming for such grade and cross section in a satisfactory manner.

Suitably protect materials mixed at a location off the roadbed against moisture loss while being transported. Spread materials without segregation. Immediately before spreading, moisten the area to be covered and keep moist, but not excessively wet.

Where the required thickness is 150 mm (6 in.) or less, spread and compact the mixture in one layer. Where the required thickness is more than 150 mm (6 in.), spread and compact the mixture in two or more layers of approximately equal thickness. Do not exceed a maximum compacted thickness of 150 mm (6 in.) in any one layer. Perform work on each layer in a similar manner. Keep the surface of the compacted material moist or prevent from drying by some approved methods until covered with the next layer.

Cement treated base to be placed in inaccessible areas may be spread in one course by approved methods. After spreading, compact the material to the required lines, grades, and cross section by means of pneumatic tampers or with other compacting equipment.

(b) Plantmix Method. Uniformly deposit the mixture on the roadbed to provide the required compacted thickness without resorting to spotting, picking up, or otherwise shifting the mixture.

When placing material on the mainline, use a wire line grade control. On areas other than the mainline, wire line grade control is optional.

Spread the mixture in one operation with a self-propelled mechanical spreader ready for compaction without further shaping. Prevent segregation of materials. Equipment not propelled by the unloading vehicle will be considered self-propelled. Provide the spreader with a screed that strikes off and distributes the material to the required width and to the surface tolerances specified. The screed shall be adjustable to the required cross section. Produce a finished surface texture of uniform appearance. If the spreader leaves ridges, indentations, or other objectionable marks in the surface that cannot be eliminated by rolling, or prevented by adjustments in operation, discontinue its use.

Equip the spreader with a control system which will automatically control the placing and trimming of the material to the specified transverse slope and established longitudinal grade. Use control system that is automatically actuated from an independent line and grade control reference on one or both sides of the roadbed. In case of failure of the control system, cease spreading operations until the system is repaired.

Except as otherwise provided in this Subsection, do not use motor graders during spreading and compacting operations. Motor graders may be used to trim the edges and surface of the cement treated base after compaction in order to finish the base within the tolerances specified.

On areas other than the mainline, with wire line grade control, motor graders may be used as self-propelled mechanical spreaders.

When motor graders are used as spreaders, equip them with end wings on the blade, and lock the blade in a position normal to the direction of travel. Provide motor graders with cross slope and automatic grade controls that are capable of picking up grade from a wire control and from an external sensing wheel.

Control the initial pass for final grade elevation by the wire line. Control subsequent passes by an electronic sensing device capable of maintaining grade. In case of failure of the control system, the motor grader may be operated manually but only until the material on the roadbed at the time of breakdown has been placed.

Reference points will be established at reasonable intervals on both sides of the mainline. Where wire control is used on other lines, reference points will be established on one side.

Furnish, place, maintain, remove, and dispose of all materials required to provide continuous line and grade control.

In areas of transitions, sharp curves, short runs, or miscellaneous areas where the above methods for control of line and grade are impractical, use an approved placement method.

Spread the mixed materials for the full planned width, unless traffic conditions require part width construction. Spread either by one spreader or by several spreaders operating in a staggered position across the subgrade. For the use of one spreader operating alternately on contiguous lanes, not more than one hour shall elapse between the time of placing material in adjacent lanes. Locate any longitudinal construction joints on lane lines.

**304.03.05 Compaction.** Accomplish rolling with a two-axle tandem steel roller weighing not less than 9 metric tons (10 tons), or single or dual drum vibratory roller, and pneumatic tired rollers conforming to Subsection 401.03.04. Use roller sequence as directed.

Perform rolling in such a manner to eliminate bumps and irregularities and finish surface to the required grade and cross section within the surface tolerances specified.

Apply water without driving equipment over the uncompacted material.

Commence rolling from the outer edge of the material. Lap subsequent rolling at least 25% over previously compacted material.

Use steel-wheeled rollers for the finish rolling of each layer. Commence finish rolling from the outer edge and progress to compact the entire surface.

Compact areas inaccessible to rollers to the required compaction by other means.

The density of compacted cement treated bases shall not be less than 92% of the maximum density as determined by Test Method No. Nev. T108. The in-place density will be determined by Test Method No. Nev. T102 or T103.

**304.03.06 Finished Surface.** The finished surface of cement treated base shall be uniform and shall not deviate at any point more than 9 mm (0.03 ft) from the bottom of a 3.6 m (12 ft) straightedge laid in any direction.

Do not vary the finished surface more than 15 mm (0.05 ft) above or below the grade established. When Portland cement concrete pavement is to be placed on cement treated base, do not extend the finished surface above the grade established.

Trim off all high spots to within the specified tolerance. Immediately after trimming, remove and dispose of excess material in an approved manner. Leave no loose material on the base. Roll the trimmed areas again.

Do not use cleated equipment on new cement treated base unless street pads are used on cleats.

**304.03.07 Time Requirements.** Do not leave any mixture of aggregate, cement, and water that has not been compacted undisturbed for more than 30 minutes. Not more than 2 hours shall elapse between the time water is added to the aggregate and cement and the time of completion of initial rolling. Not more than 3 hours shall elapse between the time water is added to the aggregate and cement and the time of completion of final compaction after trimming.

**304.03.08 Construction Joints.** When cement treated base operations are delayed or stopped for more than 2 hours, make a transverse vertical construction joint in compacted material. Do not place additional mixture until the construction joint has been approved.

Construct longitudinal joints in cement treated base by cutting vertically along the edge of the existing surface to a depth of approximately 75 mm (3 in.). Do not construct joint for at least one hour after final compaction. The material cut away may be disposed of in the adjacent lane to be constructed. Moisten the face of the cut joints in advance of placing the adjacent base.

**304.03.09 Protection and Curing.** Keep the surface moist at all times until the curing seal is applied. Use water equipment which will apply moisture in a fog or mist type application, free of pressure at the surface being treated.

Apply curing seal to the completed top layer of cement treated base. Apply the curing seal as soon as possible, but not later than 24 hours after the completion of final rolling. The curing seal shall be Cutback Asphalt, Type MC-250, applied at an approved rate. Apply the curing seal according to Section 407. At the time of application of the curing seal, the surface shall be tightly knit, free from all loose material and shall contain sufficient moisture to prevent excessive penetration of the asphalt. If necessary, apply water to fill the surface voids immediately before the asphalt is applied.

Do not permit equipment or traffic on the cement treated base during the first 3 days (4 days if Type IP cement is used) after applying the curing seal. Apply sand blotter as directed to prevent excessive surface abrasion from traffic.

When equipment or traffic is permitted on the cement treated base for the sole convenience of the Contractor, protection of the curing seal will not be paid for.

Remove all loose sand from the cement treated base before any surfacing material is placed thereon.

**304.03.10 Weather Limitations.** Do not mix or place cement treated base while the atmospheric temperature is below 2 °C (35 °F), or when conditions indicate that the temperature will fall below 2 °C (35 °F) for a sustained period of 4 hours within the next 24 hours. Do not place cement treated base on frozen ground. Protect base material from freezing and frost for a period of 5 days after placing.

METHOD OF MEASUREMENT

**304.04.01 Roadmix Method Designated for Use.** Roadmix cement treated base aggregate will be measured by the metric ton (ton). When mixed at a central mixing plant, the quantity of aggregate will be determined by weighing the completed mixture of aggregate, cement and water, and deducting from this mass the mass of the cement and water. Meter water and calibrate meters for mass.

Mixing, hauling, spreading, and compacting cement treated base will be measured by the square meter (square yard).

**304.04.02 Plantmix Method Designated for Use.** Plantmix cement treated base aggregate will be measured by the metric ton (ton), less the mass of cement. The quantity of aggregate will be determined by weighing the completed mixture of aggregate, cement, and water (in the hauling vehicle before delivery), and deducting from this mass the mass of cement.

**304.04.03 General.** Cutback asphalt used for curing seal and sand blotter will be measured under Section 407.

Portland cement will be measured by the metric ton (ton) by the following methods:

(a) Certified package mass.

(b) Certified scale masses.

(c) Certified mass certificates indicating the truck and trailer number, tare mass, gross mass, net mass, and date. The following requirements shall also apply:

1. Loaded transporting vehicles shall be occasionally weighed by project personnel before discharge of any material. The frequency in which the loaded vehicles are weighed will be determined.

2. Every empty transporting vehicle shall be weighed by project personnel before the vehicle leaves the project.

3. The quantity of Portland cement used will be determined should a discrepancy arise between project masses of the loaded or unloaded vehicles, or both, and the certified mass certificates.

BASIS OF PAYMENT

**304.05.01 Roadmix Method Designated for Use.** The accepted quantities, measured as provided above, will be paid for at the contract price per unit of measurement for the pay items listed below that are shown in the proposal. Payment will be full compensation for the work prescribed in this Section.

Payment will be made under:

| Pay Item | Pay Unit |
|---|---|
| Roadmix Cement Treated Base Aggregate (dry) | Metric Ton (Ton) |
| Portland Cement for Cement Treated Base | Metric Ton (Ton) |
| Mixing Cement Treated Base | Square Meter (Square Yard) |

**304.05.02 Plantmix Method Designated for Use.** The accepted quantities, measured as provided above, will be paid for at the contract price per unit of measurement for the pay items listed below that are shown in the proposal. Payment will be full compensation for the work prescribed in this Section.

Payment will be made under:

| Pay Item | Pay Unit |
|---|---|
| Plantmix Cement Treated Base Aggregate (wet) | Metric Ton (Ton) |
| Portland Cement for Cement Treated Base | Metric Ton (Ton) |

# SECTION 305

## ROADBED MODIFICATION

### DESCRIPTION

**305.01.01 General.** This work consists of pulverizing, blending with cement, and compacting an existing roadway.

### MATERIALS

**305.02.01 General.** Material shall conform to the following Sections and Subsections:

| | |
|---|---|
| Portland Cement | Section 701 |
| Cutback Asphalt | Subsection 703.03.03 |
| Sand Blotter | Subsection 705.03.05 |
| Water | Section 722 |

Portland cement may be either Type I, Type IP "blended," Type II, or Type V. The limitation on the amount of alkali in cements is hereby waived.

**305.02.02 Gradation Requirements.** Loosen and pulverize the existing roadway to conform to the following sieve sizes:

| Sieve Size | Percent Passing by Mass |
|---|---|
| 75 mm (3 in.) | 100 |
| 50 mm (2 in.) | 95-100 |

### CONSTRUCTION

**305.03.01 Weather Limitations.** Do not process for roadbed modification while the atmospheric temperature is below 2 °C (35 °F), or when conditions indicate that the temperature will fall below 2 °C (35 °F) for a sustained period of 4 hours within 24 hours after final compaction.

Do not proceed with the pulverization operation when the temperatures will not permit the processing operation to follow.

If atmospheric temperatures fall below 2 °C (35 °F) for a sustained period of 4 hours within 24 hours, the Engineer will determine if the processed material may remain in place. If the material is allowed to remain in place, reprocess with an additional 0.5% cement by mass. Perform such work at no cost to the Department.

**305.03.02 Preparation of Roadbed.** Pulverize the existing roadway to the depth necessary to construct the roadbed modification as shown on the plans.

Roll as directed with pneumatic tired roller and pregrade the pulverized material to within 25 mm (1 in.) of grade.

Maintain the pulverized surface in an acceptable condition, until the processing for roadbed modification begins.

Restrict the pulverization operation to half roadway width at a time.

Relay the pulverized material by one of the following methods and place public traffic thereon at the end of each working day:

(a) Relay and satisfactorily compact the unprocessed pulverized material.

(b) Add cement, process, spread, and compact the material, according to the requirements for the finished product.

Do not pulverize more than 5 km (3 mi) in advance of the completed roadbed modification process. Distribute only as much Portland cement on the pulverized surface material and base as can be mixed and compacted within the same working day.

**305.03.03 Proportioning.** Add Portland cement to the pulverized material at the rate of 2% by mass. The calculated maximum density (as determined by Test Method No. Nev. T108) of the pulverized material will be used to determine the mass of the material in place. Add the cement in a dry state and take every precaution to prevent blowing. Do not vary the rate of cement spread more than 10% from the designated rate.

**305.03.04 Mixing.** Use roadmix machine of a pugmill type, auger type, or cross-shaft type mixer capable of providing a uniform homogeneous mixture throughout the material to the depth indicated on the plans.

Furnish cement in bulk. Distribute cement, by mechanical equipment, on the pulverized material in a layer of uniform thickness. Calibrate each load in the spreading equipment so the average rate of spread can be determined. Spread the cement upon the pulverized material at an acceptable distance ahead of the roadmixing operations.

Use a roadmixing machine with provisions for introducing water at the time of mixing, through a metering device or by other approved methods. Apply the water by controls that will supply the correct quantity of water to produce a completed mixture with uniform moisture content. Leakage of water from equipment will not be permitted. Avoid the addition of any excessive water. The quantity of water added to the mixture will be determined. Do not exceed optimum water content in the complete mixture as determined by Test Method No. Nev. T108.

Mix the components to the depth shown on the plans until a uniform homogeneous mixture is obtained. If equipment is used that requires more than one pass of the mixer, make at least one pass before any water is added to the material.

**305.03.05 Compacting and Finishing.** After mixing, compact the mixture to no less than 95% relative maximum density as determined by Test Method No. Nev. T108. The in-place density will be determined by Test Methods No. Nev. T102 or T103. Accompany compaction by sufficient blading to shape the surface to the specified longitudinal grade and cross-slope, or as directed. Produce a uniform surface that is free of cracks, ruts, humps, depressions, and loose material. Correct or repair all deficiencies by approved methods.

Compact with a two-axle tandem steel roller weighing not less than 9 metric tons (10 tons), or single or dual drum vibratory roller, and pneumatic tired rollers conforming to Subsection 401.03.04. Use roller sequence as directed.

Equip motor graders with cross slope and automatic grade controls that are capable of picking up grade from an external sensing wheel.

**305.03.06 Surface Tolerances.** When a 3.6 m (12 ft) straightedge is laid in any direction, the finished surface shall not deviate at any point more than 12 mm (0.04 ft) from the bottom thereof.

Correct defective areas by approved methods.

**305.03.07 Protection and Curing.** Keep the surface moist at all times until the curing seal is applied. Use water equipment of a type which will apply moisture in a fog or mist type application free of pressure at the surface being treated.

Apply curing seal to the completed cement treated, pulverized material. Apply the curing seal as soon as possible, but not later than 24 hours after completion of final rolling. Curing seal shall be Cutback Asphalt, Type MC-250 applied at the rate shown on the plans or as directed. At the time of application of the curing seal, the surface shall be tightly knit, free from all loose material and shall contain sufficient moisture to prevent excessive penetration of the asphalt. If necessary, apply water to fill the surface voids immediately before the asphalt is applied.

Apply the curing seal according to Section 407.

Equipment or traffic may be permitted on the cement treated material when approved, after the curing seal has set and sand blotter has been applied as directed.

Maintain the cement treated material in an acceptable condition.

Remove all loose sand from the cement treated material before any surfacing material is placed thereon.

## METHOD OF MEASUREMENT

**305.04.01 Measurement.** Pulverizing the existing surface will be measured by the kilometer (mile) along centerline of the roadbed full width, or by the square meter (square yard).

Processing for roadbed modification will be measured by the square meter (square yard) for the mixing of the materials, the compaction of the mixture, and the finishing of the completed base.

Portland cement will be measured by the metric ton (ton) as determined by the following methods:

(a) Certified packaged masses.

(b) Certified scale masses.

(c) Certified mass certificates indicating the truck and trailer number, tare mass, gross mass, net mass and date. The following requirements shall apply:

1. Loaded transporting vehicles shall be occasionally weighed by project personnel before discharge of any material. The frequency in which the loaded vehicles are weighed will be determined.

2. Every empty transporting vehicle shall be weighed by project personnel before the vehicle leaves the project.

3. The quantity of Portland cement used will be determined, should a discrepancy arise, between project masses of the loaded or unloaded vehicles, or both, and the certified mass certificates.

Cutback asphalt used for curing seal and sand blotter will be measured under Section 407.

## BASIS OF PAYMENT

**305.05.01 Payment.** The accepted quantities, measured as provided above, will be paid for at the contract price per unit of measurement for the pay items listed below that are shown in the proposal. Payment will be full compensation for the work prescribed in this Section.

Payment will be made under:

| **Pay Item** | **Pay Unit** |
|---|---|
| Portland Cement | Metric Ton (Ton) |
| Processing for Roadbed Modification | Square Meter (Square Yard) |
| Pulverize Existing Surface | Kilometer (Mile) or Square Meter (Square Yard) |

# SECTION 307

## SHOULDERING MATERIAL

### DESCRIPTION

**307.01.01 General.** This work consists of shoulder preparation and placing shouldering material.

### MATERIALS

**307.02.01 General.** Material shall conform to the following Section and Subsection:

| | |
|---|---|
| Shouldering Material | Subsection 704.03.09 |
| Water | Section 722 |

### CONSTRUCTION

**307.03.01 Shoulder Preparation.** Prior to the placement of shouldering material, clear and grub all shoulders for a minimum width of 3 m (10 ft) from the edge of pavement, but no more than needed to place and compact the material. Clear and grub to remove all vegetation, organic material, trash, and non-organic material greater in size than the largest allowable gradation specified for the shouldering material, or the largest allowable gradation specified for cold millings when milled material is to be placed. Do not alter or modify existing drainage unless directed. Dispose of the material resulting from the shoulder preparation according to Subsection 107.14, unless otherwise directed.

**307.03.02 Placement and Compaction.** Initially place the shouldering material by mechanical means. Windrows exceeding 100 mm (4 in.) in height will not be allowed when the adjacent lane is open to traffic. Place all material within the limits of the prepared shoulder. Do not place material in roadway ditches or on back slopes. Grade the lower edge of the shouldering material flush with the existing slope.

Grade and compact shouldering material after paving has been completed. Finish shoulders by grading material according to Subsection 105.03. Achieve final compaction by applying enough water to adequately wet all material and roll with a steel wheeled roller at all locations unless otherwise directed. Place, finish, and compact all shouldering material to the satisfaction of the Engineer.

### METHOD OF MEASUREMENT

**307.04.01 Measurement.** Shouldering material will be measured by the metric ton (ton).

The mass of any water added to the shouldering material before weighing will be deducted from the quantity measured for payment.

### BASIS OF PAYMENT

**307.05.01 Payment.** The accepted quantities, measured as provided above, will be paid for at the contract unit price per unit of measurement for the pay item listed below that is shown in the proposal. Payment will be full compensation for the work prescribed in this Section.

Payment will be made under:

| Pay Item | Pay Unit |
|---|---|
| Shouldering Material | Metric Ton (Ton) |

# SECTION 401

## PLANTMIX BITUMINOUS PAVEMENTS — GENERAL

### DESCRIPTION

**401.01.01 General.** These specifications include general requirements that are applicable to all types of bituminous pavements of the plantmix type, irrespective of gradation of aggregate, kind and amount of bituminous material, or pavement use. Deviations from these general requirements will be indicated in the specific requirement for each type.

This work consists of constructing one or more courses of bituminous mixture on the prepared foundation.

### MATERIALS

**401.02.01 General.** Material shall conform to the following Sections and Subsection:

Bituminous Materials ..... Section 703
Aggregates for Bituminous Courses ..... Section 705
Commercial Mineral Filler ..... Subsection 705.03.03
Engineering Fabrics ..... Section 731

**401.02.02 Composition of Mixtures.** Compose the bituminous plantmix of a mixture of aggregate, mineral filler, and bituminous material. Size, uniformly grade, and combine the several aggregate fractions in such proportions that the resulting mixture meets the grading requirements of the job-mix formula.

Do not commence paving or coldmilling operations until the following requirements have been complied with:

(a) An approved mix design conforming to the requirements of this Subsection and Section 705 is received from the Department's Materials Division.

Mix Design Requirements (Plantmix and Premixed Bituminous Surface Aggregates):

| TEST | TEST METHOD | REQUIREMENTS |
|---|---|---|
| Percent Air Voids of Compacted Bituminous Mixture (Types 2 and 3) | AASHTO T269 | * 4% |
| Percent Air Voids of Compacted Bituminous Mixture (Type 2C) | AASHTO T269 | * 4% |
| Percent Air Voids of Compacted Bituminous Mixture (Types 2 and 3) (Premixed) | AASHTO T269 | 3 to 9% |
| Stabilometer Value (Type 2) | Nev. T303 | 35 Min. |
| Stabilometer Value (Type 2C) | Nev. T303 | 37 Min. |
| Stabilometer Value (Type 3) | Nev. T303 | 30 Min. |
| Indirect Tensile Strength (Unconditioned)<br>(Types 2 and 2C, except with PG 76-22NV or PG 76-22NVTR Asphalt) | Nev. T341 | 448 kPa (65 psi) Min. |
| Indirect Tensile Strength (Unconditioned)<br>(Types 2 and 2C with PG 76-22NV or PG 76-22NVTR Asphalt) | Nev. T341 | 689 kPa (100 psi) Min. |
| Indirect Tensile Strength (Unconditioned) (Type 3) | Nev. T341 | 400 kPa (58 psi) Min. |
| Indirect Tensile Strength (Retained Strength) | Nev. T341 | 70% Min. |
| Voids in Mineral Aggregate (Types 2 and 2C Plantmix Aggregate) | Nev. T338 | 12 to 22% |

* The mix design percent air void requirement may be adjusted by the Department to obtain passing values for other mix design requirements.

In addition, the mixture design will be evaluated per Nevada Test Method No. Nev. T760. Mixture designs not meeting this requirement may be rejected.

(b) Based upon the approved mix design, submit a written proposed job-mix formula for use by the Engineer in setting the job-mix to be used. For metric unit contracts, provide the proposed job-mix formula in metric units or both metric and English units. For English unit contracts, provide the proposed job-mix formula in English units or both English and metric units. Identify the asphalt cement supplier and shipping point in the job-mix formula. Include in the proposed formula definite single values for:

1. The percentage of aggregate passing each specified sieve.
2. The percentage of bitumen (bitumen ratio) to be added (to 0.1%), by dry weight of aggregate.
3. The temperature of the mixture leaving the mixer.
4. The minimum temperature of the mixture in the windrow or in the hopper of the paver.
5. The percentage of each aggregate bin used. (Bin percentages of less than 5% will not be allowed.)

The job-mix formula with the allowable tolerances shown herein shall conform to Section 705.

A job-mix formula with single values for 1, 2, 3, 4, and 5 above will be determined and notification will be given in writing. This job-mix formula shall be in effect until modified in writing by the Engineer. Furnish mixture conforming to the job-mix formula, within the following range of tolerances:

| | |
|---|---|
| Aggregate passing the 4.75 mm (No. 4) and larger sieves | ± 7% |
| Aggregate passing the 2.36 mm to 150 µm (No. 8 to No. 100) sieves | ± 4% |
| Aggregate passing the 75 µm (No. 200) sieve | ± 2% |
| Bitumen ratio | ± 0.4% dry mass of aggregate |
| Temperature leaving the mixer | ± 11 °C (20 °F) |

Job-mix formula (1) shall reflect the bitumen ratio recommended by the approved mix design. Consistently produce a mixture with a bitumen ratio at the target value. Do not use the above operational tolerance as a means to alter the bitumen ratio target value.

If the aggregates and asphalt cement submitted for a bituminous mix design produces a mixture exhibiting critical properties, see Note 1 below, be responsible for deciding whether a mixture can be produced which consistently meets project specification requirements, see Note 2 below.

If electing to use a mix design that yields a critical mix, proceed and place the field trial mixture to be subjected to testing.

If no satisfactory recommendation can be made by the Engineer from the test results of the field trial mixture, a new bituminous mix design will be required and a suspension of paving operations will be required until a new mix design is approved. Working days will continue to be charged.

If the test results are satisfactory, the paving may continue, however, the mixture will be monitored to assure that the project specification requirements are consistently met, see Note 2 below.

Note 1: A critical mixture is one where there is a narrow range in the bitumen ratio in which project specification requirements are met for Stabilometer Value and Percent Air Voids of Compacted Bituminous Mixture (being a single point value or values in the acceptable range that do not allow for a ±0.4% fluctuation from the target value in bitumen ratio and still meet Stabilometer Value and Percent Air Voids requirements). If the range in the bitumen ratio, where Stabilometer Value and Percent Air Voids specification requirements are met, is 0.7% or less, the mixture will be reported as “critical” and the above listed criteria shall be met before its use on the project.

Note 2: If two consecutive behind the paver samples (field samples) or 25% of the material sampled and tested, on a rolling 10 samples, fail to meet specification requirements for Stabilometer Value and/or Percent Air Voids, the paving operations will be shut down. Submit a plan outlining corrective measures to alleviate the failing material, and receive approval before any further paving. Working days will not be suspended during any such shutdown. (Rolling 10 samples indicates that only the preceding 10 samples will be counted in the analysis for consideration of failure, not the entire set of samples.)

On the first day of bituminous mix production for each dense-graded mix design, produce one field trial mixture conforming to job-mix formula (1) during a maximum of 4 hours of operation. Complete all work by 1:00 p.m. Produce the mixture at the medium speed used during plant calibration. Place the mixture at an approved location. Suspend production of bituminous mix for a maximum of 3 working days or until all test results, except for Indirect Tensile Strength (Unconditioned) and Indirect Tensile Strength (Retained Strength), are available. Working days will not be charged during the 3 working day suspension.

Acceptance of the field trial mixture will be based on tests results meeting the requirements of this Subsection with the aggregate gradation within the job-mix ranges given and the in-place densities meeting the requirements of Subsection 402.03.06.

When test results of the field trial mixture do not meet the requirements, additional field trial mixtures may be required and the required tests performed during one additional maximum 3 working day suspension or a new mix design may be required.

Field trial mixtures not meeting the requirements will be addressed in accordance with Subsection 105.03.

A revised job-mix formula (if applicable) will be provided based on the results of the tests performed on the field trial mixture. The target bitumen ratio will be selected, based on meeting the specifications for Stabilometer Value, Percent Air Voids of Compacted Bituminous Mixtures, and aggregate gradation.

Establish a new approved mix design and a new job-mix formula for any change in material sources. Changes include, but are not limited to, aggregate source, aggregate production method (crushing, screening, washing, or handling), asphalt supplier, asphalt shipping point, asphalt formulation, and method or rate of mineral filler addition. Each approved mix design is valid for the calendar year in which it was performed. Establish a new approved mix design and a new job-mix formula if plantmix production continues or resumes after January 1 of the following year. When unsatisfactory results make it necessary, the Engineer may establish a new job-mix formula and give notification in writing.

The final plantmix product placed on the roadway shall comply with the approved mixture design, and the following project control requirements:

| TEST | TEST METHOD | REQUIREMENTS |
|---|---|---|
| Percent Air Voids of Compacted Bituminous Mixture (Types 2 and 3) | AASHTO T269 | 3 to 6% |
| Percent Air Voids of Compacted Bituminous Mixture (Type 2C) | AASHTO T269 | 3 to 6% |
| Percent Air Voids of Compacted Bituminous Mixture (Types 2 and 3) (Premixed) | AASHTO T269 | 3 to 9% |
| Stabilometer Value (Type 2) | Nev. T303 | 35 Min. |
| Stabilometer Value (Type 2C) | Nev. T303 | 37 Min. |
| Stabilometer Value (Type 3) | Nev. T303 | 30 Min. |
| Indirect Tensile Strength (Unconditioned)<br>(Types 2 and 2C except with PG 76-22NV or PG 76-22NVTR Asphalt) | Nev. T341 | 448 kPa (65 psi) Min. |
| Indirect Tensile Strength (Unconditioned)<br>(Types 2 and 2C with PG 76-22NV or PG 76-22NVTR Asphalt) | Nev. T341 | 689 kPa (100 psi) Min. |
| Indirect Tensile Strength (Unconditioned) (Type 3) | Nev. T341 | 400 kPa (58 psi) Min. |
| Indirect Tensile Strength (Retained Strength) | Nev. T341 | 70% Min. |

Final plantmix product placed on the roadway not conforming to the requirements specified herein will be assessed demerits according to the following schedule. See Subsection 109.02, where demerits will be evaluated for damages sustained by reason of any noncompliance.

| TEST | REQUIREMENT | REJECTION LIMIT | DEMERITS (a) |
|---|---|---|---|
| Indirect Tensile Strength (Unconditioned)<br>(Types 2 and 2C except with PG 76-22NV or PG 76-22NVTR Asphalt) | 448 kPa (65 psi) Min. | 345 kPa (50 psi) Min. | (b) |
| Indirect Tensile Strength (Unconditioned)<br>(Types 2 and 2C with PG 76-22NV or PG 76-22NVTR Asphalt) | 689 kPa (100 psi) Min. | 586 kPa (85 psi) Min. | (b) |
| Indirect Tensile Strength (Unconditioned) (Type 3) | 400 kPa (58 psi) Min. | 296 kPa (43 psi) Min. | (b) |
| Indirect Tensile Strength (Retained Strength) | 70% Min. | 55% Min. | (b) |

(a) Demerits may be reduced or waived if bituminous material does not conform to Section 703. Demerits apply only to the material produced on the shift the material was sampled.

(b) Demerits will be assessed on a prorated basis by dividing the difference between the REQUIREMENT and the TEST RESULT by the difference between the REQUIREMENT and the REJECTION LIMIT and multiplying by 21. The demerit value will be rounded down to the nearest whole demerit.

Cease production if two consecutive test results or 40% of the total test results fail for Indirect Tensile Strength (Unconditioned) or Indirect Tensile Strength (Retained Strength). Evaluate available information and determine the likely cause or causes of the problem and propose a change. Additional lime will not be allowed to increase Indirect Tensile Strength (Unconditioned). Approval will not be given if the proposed change will be a detriment to other properties of the mix. Do not resume production until proposed changes have been approved. A new mix design may be required.

The maximum temperature of the mixture at the plant when using asphalt cement shall be 177 °C (350 °F).

The minimum temperature of the mixture at the paver when using asphalt cements with an “NV” or “NVTR” designation shall be 149 °C (300 °F). The minimum temperature of the mixture at the paver for all other asphalt cements shall be 121 °C (250 °F).

In no case shall the temperature of the mixture leaving the plant and arriving at the paver drop more than 11 °C (20 °F) for plantmix surfaces mixtures and 8 °C (15 °F) for plantmix open-graded mixtures when using asphalt cement.

When using cutback asphalt, the temperature of the bituminous material just before mixing, the completed mixture discharged from the mixer, and the completed mixture in the hauling vehicle just before leaving the plant shall conform to the following:

| GRADE and TYPE MC or SC | BITUMINOUS MATERIAL AND MIXTURES | |
|---|---|---|
| | Minimum °C (°F) | Maximum °C (°F) |
| 70, 70NV | 35 (95) | 60 (140) |
| 250 | 57 (135) | 79 (175) |
| 800 | 74 (165) | 96 (205) |
| 3000 | 93 (200) | 116 (240) |

In no case shall the temperature of the mixture leaving the plant and arriving at the paver drop more than 11 °C (20 °F) when using cutback asphalt.

Furnish five 3.75 L (1 gal) samples of each grade of asphalt cement or cutback asphalt specified in the contract not less than 20 working days before starting paving operations. Furnish samples of asphalt cement in paint can type containers.

Also furnish a sample of the aggregates not less than 20 working days before starting paving operations. Do not submit samples for bituminous mix designs until a minimum of 4,500 metric tons (5,000 tons) or 25% of the required contract quantity is produced proportionately in stockpile, whichever is less. Obtain samples from the produced stockpiles. The Engineer will obtain these samples or witness the Contractor obtaining them. See Subsection 106.04.

Bituminous material may be conditionally accepted at the source.

In lieu of furnishing samples of asphalt cement and aggregates for a mixture design, a mix design which has been previously performed and approved by the Department's Materials Division may be submitted for approval.

If the submitted plantmix bituminous surface aggregate and asphalt cement meet the individual specification requirements, but fail to meet the mix design requirements when combined, a one time suspension of up to 10 working days may be allowed, when deemed necessary, for resubmittal and retesting for an acceptable mix design.

If, at anytime during production, the bituminous mixture does not meet the requirements of this Section, make the necessary modification to the bitumen ratio, at own expense, in order to bring the mixture into compliance. In the event that the project control requirements are being met, and the Engineer chooses to direct an increase in the bitumen ratio above the target value resulting from the field trial mixtures, additional compensation will be provided according to Subsection 402.05.01. When additional mineral filler, above the minimum specified, is required to meet the requirements for Indirect Tensile Strength (Retained Strength), Test Method No. Nev. T341, additional compensation will be provided according to Subsection 402.05.01.

CONSTRUCTION

**401.03.01 Bituminous Mixing Plant.** (a) General. Maintain the storage yard in a neat and orderly manner. Make stockpiles, readily accessible for sampling.

Store asphalt cement in tanks separate and apart from dryer burner fuel. Tanks with separate compartments may be used only if the compartments do not have a common wall. Provide viewing port between compartments.

(b) Burner Fuel and Burner. Limit fuel used for heating aggregates to the following types; natural gas, liquefied natural gas, fuel oil (ASTM D396, Grades No. 1 and No. 2), butane, propane, diesel fuel oil (ASTM D975, Grades No. 1-D and No. 2-D).

Certify that burner fuels comply with the foregoing and provide Certificate of Compliance conforming to Subsection 106.05.

The burner used for heating the aggregate shall achieve complete combustion of the approved fuel and not leave any fuel residue that will adhere to the heated aggregate.

(c) Mixing Plants. Use mixing plants conforming to the following:

1. Requirements for All Plants. Use mixing plants of sufficient capacity to adequately handle the proposed

bituminous construction. Provide 48 hours notice before beginning mixing plant calibrations. For job-site plants, provide a copy of the current NDEP permit covering the limitations of the mixing plant production capacity not less than 48 hours before beginning calibrations.

Once an approved mix design has been received, calibrate mixing plants prior to plantmix operations, whenever a plant is moved, no less than once a year, and any other time as directed. Do not begin plantmix production until calibration procedures have been completed. Submit calibration results on NDOT Form 040-038 Plant Calibration Worksheet, or similar form, for approval. Do not operate outside the parameters of the plant calibration limits during production.

For mobile plants, produce a quantity of bituminous mixture that provides a representative sample to prove the gradation and bitumen ratio conform to the approved job-mix formula. A mobile plant is defined as a facility that has been in place, calibrated, and producing mixtures for one year or less. The requirement to produce this quantity of bituminous mixture may be waived if requested in writing and approved.

Once the plant calibration has been received and approved, allow a minimum of 24 hours prior to beginning production for calibration of the Department's ignition furnace.

a. Equipment for Preparation of Bituminous Material. Equip tanks for the storage of bituminous material to heat and hold the material at the required temperatures. Accomplish the heating by steam coils, electricity, or other approved means so that no flame shall be in contact with the tank. Design the circulating system for the bituminous material to assure proper and continuous circulation during the operating period. Make provision for measuring and sampling storage tanks.

b. Drier. Use a drier or driers which continuously agitate the aggregate during the heating and drying process.

c. Thermometric Equipment. Fix an armored thermometer of adequate range in temperature reading in the bituminous feed line at a suitable location near the charging valve at the mixer unit.

   Replacement of any thermometer by an approved temperature-recording apparatus for better regulation of the temperature of aggregates may be required. Use thermometers that record in degrees Celsius (Fahrenheit for English unit contracts).

d. Smoke and Dust Control. Install satisfactory precipitation devices, or use other methods which will meet local conditions, city, county, and State laws pertinent to air pollution.

e. Truck Scales. Except as allowed in Subsection 401.04.01, provide approved platform or silo scales conforming to Subsection 109.01.

f. Safety Requirements. Provide adequate and safe stairways to the mixer platform and sampling points and place guarded ladders to other plant units at all points where accessibility to plant operations is required. Provide access to the top of truck bodies by a platform that will allow mixture temperatures to be taken and visual inspection of the mix. Provide a hoist or pulley system to raise scale calibration equipment, sampling equipment, and other similar equipment from the ground to the mixer platform and return. Thoroughly guard and protect gears, pulleys, chains, sprockets, and other dangerous moving parts. Maintain ample and unobstructed passage at all times in and around the truck loading areas. Keep this area free from drippings from the mixing platform.

g. Baghouse Fines. If introducing baghouse fines into the mix, draw the material from a storage facility in which the material is kept in a uniform free flowing condition. Supply the baghouse fines for delivery to the plant from a positive weighing device which is interlocked, (rate of baghouse fines introduction shall automatically vary with the rate of the aggregate feeder) to the flow of each aggregate feeder. Equip the baghouse feeder to provide continuous uniform flow within 5% of the actual mass.

   Calibrate the baghouse fines feeder at two different speeds (the lowest and highest speed of anticipated operation) in relation to the speed of the aggregate feed. Provide an approved calibrated scale or weigh metering device to determine the actual mass of baghouse fines for each test. Furnish a test box having a sufficient capacity to perform the calibration testing. Calibrate the baghouse fines feed so the masses shown on the metering device are within ± 5% of the weighed mass.

   In a continuous mix and/or dryer drum plant add the baghouse fines at the asphalt feed line to insure a uniform mix.

In batch plants add the baghouse fines by the use of a separate bin.

Introduce the baghouse fines at an approved point, at a percentage determined by the Department's Materials Division, and not exceeding 2% by dry mass of the aggregate.

Consider baghouse fines as part of the aggregate, and not as a mineral filler.

h. Controls. Do not operate mixing plants with manual controls when equipped with computer controls.

i. Metering Devices. Provide means to verify material totals prior to introduction into the mixer.

2. Requirements for Batching Plants.

a. Plant Scales. Provide scales accurate to 0.5% of the maximum load that may be required. Design poises to be locked in any position to prevent unauthorized change or position. In lieu of truck scales, an approved automatic printer system which will print the masses of the material delivered may be used, provided the system is used in conjunction with an approved automatic batching and mixing control system. Document such masses by a weigh ticket for each load.

b. Feeder for Drier. Provide the plant with accurate mechanical means for uniformly feeding the aggregate into the drier so that uniform production and uniform temperature will be obtained.

c. Screens. Use plant screens capable of screening all aggregates to the specified sizes and proportions when the aggregate is proportioned after the drying operations. Plant screens may be eliminated when proportioning is done before the drying process and the aggregate is proportioned according to subparagraph 4. b., of this Subsection and prepared according to the first paragraph of Subsection 401.03.08.

d. Bins. Provide storage bins of sufficient capacity to supply the mixer when it is operating at full capacity. Arrange bins to assure separate and adequate storage of appropriate fractions of the mineral aggregates. Provide separate dry storage for mineral filler when used and equip the plant to feed such material into the mixer. Provide each bin with overflow pipes, of such size and at such locations as to prevent backing up of material into other compartments or bins. Provide each compartment with its own individual outlet gate, constructed to cut off quickly and completely. Construct bins so that samples can be readily obtained.

e. Weigh Box or Hopper. Include a means for accurately weighing each size of aggregate in a weigh box or hopper suspended on scales and of ample size to hold a full batch without hand raking or running over. The gate shall close tightly so that no material is allowed to leak into the mixer while a batch is being weighed.

f. Bituminous Control Unit. Provide satisfactory means, either by weighing or metering, for obtaining the proper amount of bituminous material in the mix within the tolerance specified. Provide means for checking the quantity or rate of flow of bituminous material into the mixer.

g. Bituminous Control. Use equipment to measure the bituminous material accurately to ±0.5%. The bituminous material bucket shall be a nontilting type with a loose sheet metal cover. Use a discharge opening or spray bar with a length of not less than 75% of the length of the mixer and which discharges directly into the mixer. Adequately heat the bituminous material bucket, its discharge valve or valves, and spray bar. Efficiently drain steam jackets, if used, and construct connections so that they will not interfere with the efficient operation of the bituminous scales. Provide bituminous material bucket with a capacity of at least 15% in excess of the mass of bituminous material required in any batch. Provide adequately heated quick-acting, nondrip, charging valve located directly over the bituminous material bucket.

Measure bituminous material by means of springless dial scales or metering devices. Provide springless dial scales with a capacity of not more than 450 kg (1,000 lb) in 1 kg (2 lb) gradations.

Provide the indicator dial with a capacity of at least 15% in excess of the quantity of bituminous material used in a batch. Construct the controls so that they may be locked at any dial setting and will automatically reset to that reading after the addition of bituminous material to each batch. Place the dial in full view of the mixer operator. Automatically control the flow of bituminous material so that it will begin when the dry mixing period is over. Discharge all of the bituminous material required for one batch in not more than 15 seconds after the flow has started. Provide the size and spacing of the spray bar openings for a uniform application of bituminous material the full length of the mixer. Provide the section of the bituminous line between the

charging valve and the spray bar with a valve and outlet for checking the meter when a metering device is substituted for a bituminous material bucket.

h. Mixer. Provide the batch mixer of a twin pugmill type, with steam jackets, or heat by other approved means and capable of producing uniform mixtures within the specified tolerances. Equip it with a sufficient number of paddles or blades set in proper order and operated at such speed as to produce a properly and uniformly mixed batch. Do not exceed 25 mm (1 in.) clearance of the paddles or blades from all fixed and moving parts. Do not use badly worn or defective paddles or blades in mixing operations.

i. Control of Mixing Time. Equip the mixer with an accurate time lock to control the operations of a complete mixing cycle. The time lock shall lock the weigh box gate after the charging of the mixer until the closing of the mixer gate at the completion of the cycle. The time lock shall lock the bituminous material bucket throughout the dry mixing period and shall lock the mixer gates throughout the dry and wet mixing periods. The dry mixing period is defined as the interval of time between the opening of the weigh box gate and the start of introduction of bituminous material. The wet mixing period is the interval of the time between the start of introduction of bituminous material and the opening of the mixer gate.

Equip the mixer with a timing device which will indicate by a definite audible or visual signal the expiration of the mixing period. The device shall measure the time of mixing within an accuracy of 2 seconds. Provide and maintain a suitable automatic device in proper working condition for counting the number of batches.

When the aggregates and the bituminous material have been combined, mix the entire mass in an approved mixer. Continue the mixing until a homogeneous mixture with a uniform coating is achieved. Do not exceed output rate greater than the manufacturer's capacity rating.

3. Requirements for Continuous Mixing Plants (Proportioned After Drying).

a. Feeder for Drier. Provide the plant with accurate mechanical means for uniformly feeding the aggregate into the drier so that uniform production and uniform temperature will be obtained.

b. Screens. Provide plant screens capable of screening all aggregates to the specified sizes and proportions.

c. Bins. Provide storage bins of sufficient capacity to supply the mixer when it is operating at full capacity. Arrange bins to assure separate and adequate storage of appropriate fractions of the mineral aggregates. Provide separate dry storage for mineral filler when used and equip the plant to feed such material into the mixer. Provide each bin with overflow pipes, of such size and at such locations as to prevent backing up of material into other compartments or bins. Provide each compartment with its individual outlet gate. Construct bins so that samples can be readily obtained. Equip bins with adequate telltale devices to indicate the position of the aggregates in the bins at the lower quarter points.

d. Aggregate Proportioning. Provide a means for accurately proportioning each size of aggregate after the drying operation.

Provide a mechanical feeder mounted under each compartment bin. Each compartment bin shall have an accurately controlled individual gate for volumetrically measuring the material drawn from each compartment. The feeding orifice shall be rectangular with one dimension adjustable by positive means. Provide indicators for each gate to show the respective gate opening.

Provide a meter for determining the rate of each feeder, or a revolution counter.

e. Mass Calibration of Aggregate. Provide a means for calibration of each aggregate feeder by weighing test samples. Provide accurate scales and test boxes for this mass calibration.

f. Bitumen Metering Device. Introduce the bituminous material into the mixer through a positive displacement metering device. Equip this metering device with a ready means of varying the bituminous material delivery rate.

g. Synchronization of Aggregate Feed and Bituminous Material Feed. Provide satisfactory means to afford a positive interlocking control between the flow of each feeder and the flow of bituminous material. The interlocking control shall indicate a visible or audible signal when the level of material in any one feeder approaches the strike off capacity of the feed gate, or shut the plant down.

h. Mixer. Include a continuous mixer of an approved type, adequately heated and capable of producing a uniform mixture within the job-mix tolerances. Use paddles adjustable for angular position on the shafts and reversible to retard the flow of the mix. The mixer shall have a manufacturer's plate giving the net volumetric contents of the mixer at the several heights inscribed on a permanent gage. Provide bin graphs showing the rate of feed of aggregate in metric tons (tons) per hour.

i. Surge Bins. Equip the plant with an approved surge bin at the discharge. Provide surge bin in excess of 18.1 metric tons (20 tons), and equip with an approved surge batcher or other approved method that will prevent segregation of the bituminous mixture as it is being discharged into the hauling vehicle.

4. Requirements of Continuous Mixing Plants (Proportioned Before Drying).

a. Aggregate Stockpiles. The first paragraph of Subsection 401.03.08 shall apply.

b. Aggregate Proportioning. Include a means for accurately proportioning each size of aggregate before the drying operation. Separate each compartment bin by a vertical divider of adequate height to prevent aggregate spillover from adjacent bins. In addition, provide each bin with an accurate method of regulating and measuring the material being drawn from the bin. Provide indicators for each bin to show respective feed rates.

c. Mass Calibration of Aggregate. Prior to the mass calibration of the aggregate weigh belt, calibrate each aggregate feeder bin. Once the feeder bins have been calibrated, supply a graph of each aggregate feeder bin showing the speed of the belt versus metric tons (tons) per hour of material.

Calibrate the aggregate weigh belt at three different speeds, (lowest, medium, and the highest speed of anticipated operation). Provide platform scales with a Certificate of Inspection as required in Subsection 109.01 in the same pit as the plant. Furnish a test box having a minimum capacity to perform the calibration testing. Nine metric tons (10 tons) will be the minimum amount required for a valid test. Calibrate the aggregate feed so the masses shown on the metering device are within ±1% of the actual mass as weighed on the certified platform scales. The difference of the three runs shall be within 1% of each other.

d. Bitumen Metering Device and Calibration. Introduce the bituminous material into the mixer through a positive displacement metering device. Equip this metering device with a ready means of varying the bituminous delivery rate. Calibrate the bitumen metering device at 3 different speeds (lowest, medium, and the highest speed of anticipated operation) in relation to the aggregate feed using the bitumen ratio set forth in the approved mix design. Provide platform scales with a Certificate of Inspection as required in Subsection 109.01 in the same pit as the plant. Use a vessel for calibration having a minimum capacity to perform the calibration testing. A minimum of 3,785 L (1,000 gal) will be the required amount of bitumen for a valid test. If approved, other certified devices may be allowed. Calibrate the bitumen feed so the masses shown on the metering device are within ±0.5% of the actual mass as weighed on the certified platform scales.

e. Synchronization of Aggregate Feed and Bituminous Material Feed. Provide satisfactory means to afford a positive interlocking control between the flow of each feeder and the flow of bituminous material. The interlocking control shall indicate a visible or audible signal when the level of material in any one feeder approaches the strike off capacity of the feed gate, or shut the plant down.

f. Mixer. Include a continuous mixer of an approved type, adequately heated and capable of producing a uniform mixture within the job-mix tolerances. Use paddles adjustable for angular position on the shafts and reversible to retard the flow of the mix. Retard the flow of material through the mixer by reversing a minimum of the last two rows of paddles or providing a material dam. The mixer shall have a manufacturer's plate giving the net volumetric contents of the mixer at the several heights inscribed on a permanent gage. Provide charts showing the rate of feed of aggregate per minute for the aggregate being used.

g. Surge Bins. Equip the plant with an approved surge bin at the discharge. Provide surge bin in excess of 18.1 metric tons (20 tons) capacity, and equip with an approved surge batcher or other approved method that will prevent segregation of the bituminous mixture as it is being discharged into the hauling vehicle.

h. Screens. Provide plant screens capable of screening all aggregates to the specified sizes and proportions.

5. Requirements for Dryer Drum Mixing Plants. The requirements of subparagraph 4 of this Subsection shall apply, with the exception of subparagraph 4. f.

a. Mixer. Include a mixing device which will obtain a homogeneous mixture with a uniform coating. The mixing output shall not exceed the manufacturer's capacity rating.

**401.03.02 Hauling Equipment.** Use trucks for hauling bituminous mixture with tight, clean, and smooth metal beds which may be thinly coated with a minimum amount of one of the asphalt release agents listed in the QPL to prevent the mixture from adhering to the truck beds. Do not use diesel or kerosene.

Discharge the bituminous mixture from the surge-storage system directly into the hauling vehicle.

**401.03.03 Pavers.** Use pavers that are self contained, power-propelled units, provided with an activated screed or strike-off assembly, heated if necessary, and capable of spreading and finishing courses of bituminous mixture in lane and shoulder widths applicable to the specified typical section and thicknesses shown on the plans.

Equip pavers with a receiving hopper having sufficient capacity for a uniform spreading operation. Equip the hopper with a distribution system to place the mixture uniformly in front of the screed.

Equip the screed with automatic controls which will make adjustments in both transverse and longitudinal direction. The external longitudinal reference devices used to pick up grade information for the automatic sensing control shall conform to the following:

When picking up grade information from an underlying base, the external longitudinal reference device shall be a floating beam at least 9 m (30 ft) long or an 8 m (27 ft) non-contact averaging ski with a minimum of 4 sensors.

When picking up grade information from an adjacent compacted pavement course or a concrete surface, the external longitudinal reference device shall be a floating beam or a non-contact averaging ski with a minimum of 2 sensors. Either referencing device shall be at least 3 m (10 ft) in length.

When using a floating beam to pick up grade information, place the sensing device in the middle third of the floating beam.

A non-contact sensor may be used to pick up grade information from a newly placed adjacent compacted course only when approved.

Should the automatic controls fail to function properly, finishing the half shift with manual controls may be approved. Do not resume until the controls are repaired.

**401.03.04 Rollers.** Rollers shall meet the following requirements:

(a) Breakdown rollers shall be a 2 axle tandem steel wheeled weighing not less than 9.1 metric tons (10 tons) and capable of rolling with or without vibration.

(b) Pneumatic tired rollers shall weigh not less than 9.1 metric tons (10 tons) and be equipped with pneumatic tires of equal size and diameter mounted on 2 axles attached to a rigid frame equipped with a loading platform or body suitable for ballast loading. The minimum width between the outer edge of the outside tires on a given axle is 1.5 m (60 in.). Use tires with satisfactory treads. Space the tires on the rear axle so that the entire gap between adjacent tires on the front axle will be covered by the tread of the rear tires. Uniformly inflate the tires so that the air pressure in the tires will not vary more than 35 kPa (5 psi). Use the tire manufacturer's recommended inflation pressure. Use a minimum tire size of 185 mm x 375 mm (7.5 in. x 15 in.), 4 ply. Fully skirt the roller with rigid material to within 25 mm (1 in.) of pavement surface.

(c) The finish roller shall be a 2 axle tandem steel wheeled weighing not less than 7.2 metric tons (8 tons).

**401.03.05 Weather Limitations.** Do not place plantmix bituminous surface when frozen materials are present in the base.

Do not place plantmix bituminous surface during rain or snowfall or when the roadway is wet.

Place plantmix bituminous surface when the atmospheric temperature is above those listed below:

| Compacted Thickness | Atmospheric Temperature |
|---|---|
| Less than 25 mm (1 in.) | 13 °C (55 °F) |
| 25 mm to 50 mm (1 to 2 in.) | 7 °C (45 °F) |
| Greater than 50 mm (2 in.) | 2 °C (35 °F) |

Place plantmix bituminous surface only when the surface temperature is above 10 °C (50 °F).

Place open-graded plantmix surface only when the atmospheric temperature and the pavement surface temperature are above 15 °C (60 °F).

**401.03.06 Preparation of Existing Surface.** When the surface of the existing pavement or old base is irregular, bring it to a uniform grade and cross section as directed.

Paint contact surface of curbing, gutters, manholes, and other structures with a thin, uniform coating of emulsified asphalt before the bituminous mixture is placed.

**401.03.07 Preparation of Bituminous Materials.** Heat the bituminous material to the specified temperature in a manner that will avoid local overheating and provide a continuous supply of the bituminous material to the mixer at a uniform temperature at all times.

Maintain asphalt cements with an “NV” or “NVTR” designation in storage tanks at a minimum temperature of 149 °C (300 °F) during the production of bituminous mixtures. Continuously circulate or moderately agitate the asphalt in the storage tanks during the production of bituminous mixtures.

**401.03.08 Preparation of Aggregates.** Separate aggregates proportioned before the heating and drying process, into two general sizes: (1) that portion of the material having a minimum of 80% passing a 4.75 mm (No. 4) sieve, and (2) that portion of the material having a minimum of 80% retained on a 4.75 mm (No. 4) sieve. Maintain the material within these limits with a uniformity of ± 5%. Store each portion of the material separately. When moving the aggregate from storage to compartment bins, use any method which will not cause segregation, degradation, or combinations of aggregate which fail to meet the specified gradation requirements. Do not commence plantmix operations until a minimum of 4,500 metric tons (5,000 tons) combined has been proportionately stockpiled and marinated, unless the tonnage required is less than 4,500 metric tons (5,000 tons).

Screen aggregates proportioned immediately after the heating and drying process into a minimum of two fractions if minus 12.5 mm (1/2 in.) aggregate is used, and into a minimum of three fractions when larger sized aggregate is used. Convey the screened material to separate compartments ready for proportioning, and mixing with bituminous material. Do not commence plantmix operations until a minimum of 4,500 metric tons (5,000 tons) has been proportionately stockpiled and marinated, unless the tonnage required is less than 4,500 metric tons (5,000 tons).

When the required tonnage is more than 4,500 metric tons (5,000 tons), then maintain a minimum of 4,500 metric tons (5,000 tons) of material proportionately stockpiled and marinated until such time as 4,500 metric tons (5,000 tons) or less are needed to complete the plantmix operations. Place the aggregates in the cold feed proportioning bins directly from the stockpile. Do not charge the cold feed bins from the crushing plant.

The plasticity index for any individual stockpile for use in the plantmix products before marination shall not exceed 10. Correct the plasticity problem if the plasticity index of any individual stockpile exceeds 10 before marinating the material. Do not blend with sand to lower the plasticity index.

(a) Mineral Filler Feeding. Add mineral filler to all plantmix bituminous aggregates according to the Marination Method.

1. Marination Method. Wet cure the coarse aggregates with mineral filler at a minimum rate of 1% of the mass of dry aggregate. Wet cure the fine aggregates with mineral filler at a minimum rate of 2% of the mass of the dry aggregate. The exact rate of application shall be as approved. Marinate (wet cure) the aggregates in stockpiles for a minimum of 48 hours. Fine aggregate stockpiles have a minimum of 50% passing the 4.75 mm (No. 4) sieve. All other stockpiles will be treated as coarse aggregate. Marinate stockpiles individually. Do not use the marination method process to combine stockpiles.

Use the wet cured aggregate in the stockpile within 60 days.

Before the introduction of the mineral filler, add sufficient moisture by way of spray bars at the aggregate bins to bring the aggregate to a moisture content where enough free surface moisture is available to thoroughly wet the aggregate and activate the lime. The actual amount of moisture shall be as approved. After the addition of water and mineral filler, mix the aggregate using a horizontal twin-shaft pugmill with a minimum effective mixing length of 1.5 m (5 ft). Use mixing paddles which are adjustable for angular position on the shaft to permit altering of the mixing pattern or retarding the flow to insure that the aggregate is thoroughly coated with mineral filler.

Do not extend the volume of material in the pugmill above the vertical position of the blade tips. Retard the flow of material through the pugmill by reversing a minimum of the last two rows of paddles or providing a material dam.

Draw mineral filler from a storage facility in which the mineral filler is agitated by air or other means to keep it in a uniform free flowing condition. Deliver the mineral filler to the mixer from a positive weighing device which is interlocked, (actuate electric driven feeders from the same circuit) to the flow of each aggregate feed. Equip the mineral filler feeder to provide a continuous uniform flow to within 5% of the required amount. Provide an aggregate feed and weight system which meets the requirements of Subsection 401.03.01.

Calibration of the aggregate weigh belt shall conform to Subsection 401.03.01 (4.c) with the exception that marinated material is not required.

Calibrate the mineral filler feeder at two different speeds (the lowest and highest speed of anticipated operation) in relation to the speed of the aggregate feed. Use a target of 1% mineral filler for the low speed metric tons (tons) per hour and 2% mineral filler for the high speed metric tons (tons) per hour. Provide an approved calibrated scale or weigh metering device to determine the actual mass of mineral filler for each test. Furnish a test box having a sufficient capacity to perform the calibration testing. Calibrate the mineral filler feed so the masses shown on the metering device are within ± 5% of the weighed mass.

2. Cold Feed Method. The Cold Feed Method is not allowed for use unless specifically stated in the Special Provisions. When the Cold Feed Method is allowed for use, add hydrated lime (hereinafter referred to as mineral filler) to all plantmix bituminous aggregates at the rate of not less than 1% nor more than 2.5% of the mass of the dry aggregate. The exact rate of application shall be as approved.

Draw mineral filler from a storage facility in which the mineral filler is agitated by air or other means to keep it in a uniform free flowing condition. Deliver the mineral filler to the mixer from a positive weighing device which is interlocked, (actuate electric driven feeders from the same circuit) to the flow of each aggregate feeder. Equip the mineral filler feeder to provide continuous uniform flow to within 5% of the required amount.

In continuous mix and drum dryer plants, add mineral filler to the aggregate after the aggregate is proportioned.

In batch plants, add the mineral filler to the aggregate before drying.

Before the introduction of the mineral filler, add sufficient moisture by way of spray bars at the aggregate bins to bring the aggregate to a moisture content where enough free surface moisture is available to thoroughly wet the aggregate and activate the lime. The actual amount of moisture shall be as approved. After the addition of water and mineral filler, mix the aggregate using a horizontal twin-shaft pugmill with a minimum effective mixing length of 1.5 m (5 ft). Use mixing paddles which are adjustable for angular position on the shaft to permit altering of the mixing pattern or retarding the flow to insure that the aggregate is thoroughly coated with mineral filler. Do not extend the volume of material in the pugmill above the vertical position of the blade tips. Retard the flow of material through the pugmill by reversing a minimum of the last two rows of paddles or providing a material dam. Directly introduce the completed mixture into the hotplant. Do not stockpile the completed mixture.

Interlock the moisture control valve with the hotplant control room so the moisture control valve is automatically turned off when the cold feed belts are shut off. The control valve shall also turn on automatically when the cold feed belts are activated.

**401.03.09 Mixing.** Do not exceed a moisture content of 1% in the bituminous mixture just behind the paver as determined by Test Methods No. Nev. T112 (Method A) or T306. Take satisfactory corrective action before resuming plantmix operations should the aggregate contain excessive moisture when heated within the temperature limits.

Combine the dried aggregate in the mixer in the amount of each fraction of aggregates required to meet the job-mix formula. Measure and gage the bituminous mixture and introduce into the mixer in the amount specified by the job-mix formula.

When the aggregates and the bituminous material have been combined, mix the entire mass in an approved mixer. Continue mixing until homogeneity and a uniform coating are achieved. Do not exceed the manufacturer's capacity rating for the output rate.

Should the mixture at the discharge of the mixer, at the plant, in the haul vehicle, or in place, show a nonuniform or nonhomogeneous mix, show an excess or deficiency of bitumen, show injury or damage due to burning or

overheating, show an improper combination of aggregates, show a separation of the bituminous material from the aggregates, or fail to conform to specification requirements, it will be rejected. Provide an adequate access point at the mixer discharge for sampling. If the unsatisfactory mix, as referred to above, is still in the truck, dispose of the mix, or if it has been placed, remove, dispose, and replace the mix.

Immediate control of the bitumen ratio for bituminous mixtures will be accomplished by testing the completed mixture according to Test Method No. Nev. T761.

For the job-mix formula values listed in Subsection 401.02.02, take corrective measures at the plant before production continues if two consecutive test results indicate the material is out of tolerance. If three consecutive test results for any one job-mix formula property are outside of tolerance, cease production until test results or other information satisfactorily indicate that the next material to be produced will meet the specified values. When directed, produce a sufficient quantity of bituminous mixture to prove the material is within specification prior to beginning full production.

**401.03.10 Spreading and Finishing.** Place each course of the plantmix bituminous surface full width. Any portion of the course may be advanced only to the extent of one day's operation before beginning work on a succeeding width. Complete the course to its full plan width before any general longitudinal advancement beyond the width first placed. Bring all portions of the course to as near the same point as practicable before suspending paving operations for more than one day, unless otherwise ordered.

Dump the mixture on the prepared surface and spread with the spreading and finishing machine.

If windrow pick-up equipment is used, make it capable of removing and loading all of the mixture deposited on the roadbed into the spreading and finishing machine.

Do not turn hauling equipment in areas where such turning may result in tearing, gouging, or distortion of the edges of a previously laid pad of bituminous material. Immediately discontinue any turning causing such damage, and repair.

Lay the mixture upon an approved surface, spread, strike off to grade and elevation established. Use bituminous pavers to distribute the mixture either over the entire width or over such partial width as may be practical.

Regulate the forward rate of travel of the paving machine to a speed dependent upon the capacity of the mixing plant to furnish the mixture. Move the machine at a uniform rate with a minimum amount of stopping.

On areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impracticable, spread, rake, and lute the mixture by hand tools. For such areas, dump, spread, and screed the mixture to give the required compacted thickness.

**401.03.11 Rolling.** Thoroughly and uniformly compact the pavement by rolling.

Thoroughly compact the edges of pavements not accessible to conventional rollers with suitable types of tampers, plates, trench rollers, etc.

Commence initial rolling at the lower edge and progress towards the highest portion of the roadbed.

Perform rolling in a manner that avoids cracking, shoving, or displacement.

Use rollers in good condition and capable of rolling and changing direction without adversely affecting the mat.

Properly moisten the wheels of the rollers to prevent adhesion of the hot mix asphalt. Use clean water or asphalt release agents listed in Subsection 401.03.02 of the QPL.

Perform all compactive rolling, defined as initial or intermediate, while the surface temperature of the mat is above 85 °C (185 °F).

Complete finish rolling within the same day of placement of the plantmix bituminous surface while the surface temperature of the mat is above 68 °C (155 °F).

**401.03.12 Joints.** Place the bituminous material as continuously as possible. Do not pass rollers over the unprotected end of a freshly laid mixture.

(a) Longitudinal. Offset longitudinal construction joints of successive courses of bituminous pavement at least 150 mm (6 in.).

Place bituminous pavement so that any longitudinal joints constructed are within 300 mm (12 in.) of the final traffic lane lines.

Do not construct two longitudinal joints within the same traffic lane.

(b) Transverse. Expose the full depth of the layer and form a clean vertical edge.

Place additional mixture to provide a 1:50 (50:1) transition on dense-graded plantmix bituminous surface. Remove transition material prior to continuing paving operations away from the transverse joint. No direct payment will be provided for this work.

Place a brush coat of asphalt emulsion on contact surface of the joint before additional mixture is placed.

**401.03.13 Surface Tolerances.** Surface tolerances will be specified under the respective sections of bituminous pavement.

**401.03.14 Surfacing Miscellaneous Areas.** Areas which may be included in this work are the surfacing of road and driveway approaches, median strip areas, island areas, sidewalks, dikes (excluding plantmix shoulder dikes), gutters, gutter flares, ditches, downdrains, spillways, aprons at the end of drainage structures, and other designated areas outside the traveled way.

Eliminate the 12.5 mm (1/2 in.) and larger aggregate and increase the bitumen ratio by not less than 1% by dry weight of aggregate over the dense-graded job-mix formula in the bituminous mixture placed in gutters, gutter flares, dikes, down drains, spillways, aprons at the end of drainage structures, and other designated areas outside the traveled way. A revised job-mix formula is not required.

The bituminous mixture placed in these miscellaneous areas, except for approaches, may be spread in one layer. Compact to the required lines, grades, and cross section.

**401.03.15 Pavement Reinforcing Fabric.** Deliver and store pavement reinforcing fabric according to the manufacturer's recommendations. Do not store the fabric directly on the ground and keep the fabric in a dry covered condition free from dust, dirt, and moisture

Prior to the commencement of fabric placement, have a representative from the fabric manufacturer provide an informational/training session to educate personnel on proper installation procedures and specifications, and ensure cooperation and understanding among the Department's inspectors and Contractor personnel. Attendance is mandatory for all personnel involved with the project including inspectors, consultants, and Contractor personnel. Give notification of the date, time, and location of the informational/training session a minimum of 7 days prior to the scheduled date.

The manufacturer's representative shall be on site for the first two days of the fabric installation, or longer at the discretion of the Engineer, and shall monitor the operation to ensure proper installation.

Prior to placing the fabric, assure that pavement is clean enough to provide significant adhesion to the fabric as approved by the Engineer and the manufacturer’s representative. If necessary, clean the pavement with a mechanical device by sweeping or vacuuming.

If recommended by the manufacturer’s representative, apply a tack coat to the pavement surface prior to fabric placement at the application rate specified by the representative. The exact application rate shall be determined and adjusted by the representative. Apply additional tack coat as required to the fabric and underlying plantmix surface as necessary to bond the two plantmix layers together, as directed. Total tack coat application shall not exceed 0.45 L/m$^2$ (0.10 gal/yd$^2$).

Prior to commencement of fabric placement, select an area on the shoulder of the pavement and conduct a pull test according to the fabric manufacturer's recommendation to assure adequate fabric adhesion to the pavement.

Place the fabric when the pavement surface temperature is within the range as recommended by the fabric manufacturer’s representative.

Lay the fabric by mechanical means or by hand methods under sufficient tension to eliminate ripples, creases, and bubbles. Remove such irregularities by pulling the fabric tight or in extreme cases by cutting and overlaying the cut area with a fabric patch with an overlap as recommended by the fabric manufacturer's representative.

Lap transverse and longitudinal joints with an overlap as recommended by the fabric manufacturer's representative. When laying fabric in multiple lanes, place fabric so that a minimum of 150 mm (6 in.) of fabric will extend beyond the edge of paving in order to ensure enough material for the required longitudinal overlap.

Do not allow public traffic on the installed fabric. Ensure adequate adhesion of the fabric to the pavement prior to allowing construction traffic on the installed fabric. Make every effort to prevent damage to the fabric. Use care when turning or braking and allow construction traffic to travel on the installed fabric only in the direction of the paving operation. Keep the fabric clean of mud, dust, and other debris. Repair damaged sections or areas where foreign material has come between the surface and the fabric. Remove damaged sections and foreign material that comes between the surface and the fabric by cutting the fabric and removing such material. Clean the surface and place a fabric patch per the fabric manufacturer's recommendation. Take care to insure fabric placement is made as flat and smooth as possible.

Do not place more fabric than can be covered by plantmix in the same shift. Cease all construction activities directly involving fabric placement and plantmix paving if slippage of the fabric occurs due to the elevated temperature of the roadway surface. Construction activities may resume only when the temperature of the roadway surface declines to the point at which it no longer causes slippage of the fabric.

**401.03.16 Shoulder Dikes.** Shape and compact dikes with an extrusion machine or other equipment to the required cross section.

Eliminate the 12.5 mm (1/2 in.) and larger aggregate and increase the bitumen ratio by not less than 1% by dry weight of aggregate over the dense-graded job-mix formula in the bituminous mixture placed in shoulder dikes. A revised job-mix formula is not required.

## METHOD OF MEASUREMENT

**401.04.01 Measurement.** Plantmix surfacing will be measured by the metric ton (ton) of completed mixture of aggregate, asphalt, and mineral filler.

Shoulder dikes will be measured by the linear meter (linear foot) for placing. Length will be determined from measurements taken along the top of the dikes. The quantities of bituminous mixture used to construct the dikes will be measured as set forth above.

Plantmixing miscellaneous areas will be measured by the square meter (square yard) for placing. Areas to be included in such measurement shall be limited to those areas listed in the plans, plus or minus authorized changes. Areas will be measured one time only, without consideration of the number of lifts or types of bituminous mixtures involved. The quantities of bituminous mixture used to pave the miscellaneous areas will be measured as set forth above.

Pavement reinforcing fabric will be measured by the square meter (square yard) of surface area covered. No allowance will be made for material overlap.

Batch masses will not be permitted as a method of measurement unless the alternate provisions of Subsection 401.03.01, (c)2.a., are met, in which case the cumulative mass of all the acceptable batches will be used for payment.

## BASIS OF PAYMENT

**401.05.01 Payment.** The accepted quantities of pavement reinforcing fabric, measured as provided above, will be paid for at the contract price per unit of measurement for the pay item listed below that is shown in the proposal. Payment will be full compensation for the work prescribed in this Section. All other quantities, measured as provided above, will be paid for as provided in the respective sections for each type specified.

Payment will be made under:

| Pay Item | Pay Unit |
|---|---|
| Pavement Reinforcing Fabric | Square Meter (Square Yard) |

# SECTION 402

## PLANTMIX BITUMINOUS SURFACE

### DESCRIPTION

**402.01.01 General.** This work consists of constructing one or more courses of dense-graded bituminous pavement on a prepared base.

### MATERIALS

**402.02.01 General.** Material shall conform to the following Subsections:

General ..... Subsection 401.02.01
Composition of Mixtures ..... Subsection 401.02.02

**402.02.02 Recycled Asphalt Pavement.** Recycled asphalt pavement (RAP) may replace 5 to 15%, by mass, of the total aggregate in Type 2 or Type 2C plantmix bituminous mixtures. Individual bin percentages of RAP shall be 5% minimum.

After the initial selection of the percentage of RAP to be used, changes to the percentage of RAP material will not be allowed without a new mix design.

The RAP material shall not be contaminated with concrete, aggregate base, soil, or other objectionable material. The Department will evaluate the RAP and determine if the material will be allowed for use.

Crush and process RAP in a manner that produces one or more stockpiles of uniform material that are 100% passing the 12.5 mm (1/2 in.) sieve.

The RAP material will not require marination.

Stockpile the RAP to be used in the production of bituminous plantmix for the Department separate from other RAP and virgin aggregate stockpiles. Take one informational sample of the RAP material for every 500 tons that is stockpiled. For each informational sample, test the RAP material for gradation, bitumen ratio, and extracted aggregate gradation. Recover aggregates from the RAP material by test method AASHTO T164. The results for bitumen ratio shall not vary more than 2% between any two results. Analyze the aggregate extracted from the RAP material for gradation by test method AASHTO T30. Submit the test results of the informational samples prior to sampling for a mix design. The results of the informational samples will be reviewed by the Department and will be used to accept the RAP submitted for the mix design.

Testing personnel are required to be qualified in the Nevada Alliance of Quality Transportation Construction (NAQTC) Asphalt Extended Module which includes AASHTO T164 and AASHTO T30.

Calibrate and interlock the system used to deliver the RAP to the mixer in accordance with Subsection 401.03.01.

If RAP is used, for test methods that require the material to be dried, allow an additional 24 hours for the completion of testing.

If utilizing RAP, furnish samples of asphalt cement, aggregates, and RAP not less than 30 working days before starting paving operations.

### CONSTRUCTION

**402.03.01 General.** The construction requirements shall conform to Subsections 401.03.01 through 401.03.14, inclusive, with the exceptions contained in the following Subsections.

**402.03.02 Rollers.** Use approved equipment for compaction of plantmix bituminous surface. Size rollers to achieve the required results. Use at least two rollers, one steel wheeled and one pneumatic tired with each paver.

Provide pneumatic tired rollers conforming to Subsection 401.03.04 (b).

**402.03.03 Equipment.** Furnish and operate a pavement core drilling machine for coring samples of compacted bituminous mixtures for density testing. Bring the pavement core drilling machine on the job-site 5 working days before paving operations. The core drilling machine shall conform to the following requirements:

(a) Trailer mounted (equip trailer with leveling devices).

(b) Sliding base to allow for minor location changes.

(c) Core size shall be 100 mm (4 in.).

(d) Capable of producing a non-distorted core.

(e) Pressurized water system.

(f) Include diamond circular bits.

Furnish and operate a California type profilograph for checking riding tolerances at the time and date ordered. Equip the profilograph with a 7.6 m (25 ft) wheel base and the following features:

(a) 3-Unit Frame Assembly.

1. All welded construction of light weight aluminum square tubing.

2. Index frame connections by 4 steel locating pins and secured by 4 quick acting clamps rated at 3.6 kN (800 lb) each.

(b) Multiple Wheel Assemblies.

1. Wheel supports of square steel tubing and all welded construction.

2. Secure connections by quick acting clamps.

3. Wheels with cast aluminum hubs, ball bearings, and cushion rubber tires.

4. Bearing support caster wheel assemblies.

5. Steerable front wheels from the center of the machine.

6. Rear wheels with a quick setting manual adjustment for turning in a short radius, moving sideways, and to prevent rear end crabbing on superelevations.

(c) Recording Wheel Assembly.

1. Frame of all welded construction of light weight rectangular aluminum tubing.

2. Light weight 600 mm (24 in.) minimum diameter recording wheel with heavy duty spokes for maximum rigidity, with a pneumatic tire maintained at 170 kPa (25 psi) air pressure unless otherwise specified by the manufacturer.

(d) Recorders (computerized required).

1. A high resolution printer capable of printing the profile trace to the specified scale and automatic positioning and marking of the specified “blanking band” and “must grind” bumps. It shall also be capable of printing station numbers, distances, and comments entered by the operator via keypad while measuring the profiles.

2. It shall also calculate the profile index in mm per km (in. per mi) per each 0.1 km (0.1 mi) section without hand calculations or data reduction.

3. A display screen for instant visual observation of the road profile and “must grind” areas while measurements are being taken.

4. The horizontal chart scale shall be 25 mm (1 in.) equals 7.6 m (25 ft) and the vertical scale shall be 25 mm (1 in.) equals 25 mm (1 in.). The recorder shall have an adjustment feature to calibrate the scales to these parameters. Calibrate the profilograph before usage to be accurate within 0.1 m in 100 m (0.5 ft in 500 ft) longitudinally.

5. Battery backed up memory shall retain control parameters when the system is powered down.

6. Capable of accurate operation in ambient temperatures from 7 °C to 49 °C (45 °F to 120 °F).

Alternative equipment may be allowed upon approval. As part of the approval process, provide all calibration information for review. Refer to Test Method No. Nev. T446 for calibration procedure.

**402.03.04 Spreading and Finishing.** Place bituminous plantmix surface in courses not exceeding 75 mm (3 in.) in compacted thickness. Place more than one course in equal thicknesses.

Spread bituminous plantmix surface having a width of 2.4 m (8 ft) or more as specified in Subsection 401.03.10. When the areas are less than 2.4 m (8 ft) in width, the material may be deposited and spread by other mechanical means that will provide a uniform smoothness and texture.

**402.03.05 Surface Tolerances.** Produce completed surfacing which is smooth and free from ruts, humps, depressions, or irregularities. Eliminate ridges, indentations, or other objectionable marks left in the surface by rolling or other means. Discontinue use of equipment that leaves ridges, indentations, or other objectionable marks in the bituminous surface, or does not consistently produce a surface meeting the profile index requirements.

After final rolling, the smoothness of the final dense-graded surface course shall meet the straightedge measurement and profilograph measurement. Furnish the specified profilograph and perform the profilograph measurement.

(a) Straightedge Measurement. The Engineer will perform this measurement. When a straightedge 3.6 m (12 ft) long is laid on the finished surface and parallel with the centerline of the highway, the surface shall not vary more than 7.5 mm (0.3 in.) from the lower edge of the straightedge. When a straightedge 3.6 m (12 ft) long is laid on the finished surface and at right angles with the centerline, the surface shall not vary more than 7.5 mm (0.3 in.) from the lower edge of the straightedge.

Correct defective areas by approved methods.

(b) Profilograph Measurement. Measure profiles within each traffic lane at 1 m (3 ft) from and parallel to the right traffic lane line. Measure profiles for the entire length of each traffic lane within 48 hours after each day's placement of plantmix bituminous mixture.

Perform the profilograph measurement in the direction of traffic.

Mark the pavement surface with paint at least every 0.2 km (0.2 mi). Mark excessive high points, as defined below, with paint during the initial run of the profilograph.

Do not measure pavement on horizontal curves having centerline radius less than 300 m (1,000 ft). Do not measure pavement within 10 m (30 ft) of a concrete bridge deck (including approach slabs) unless the bridge deck also is to be overlayed with plantmix bituminous surface.

Operate the California type profilograph at a speed of 5 km/hr (3 mph) or less.

Towing the profilograph while measuring profiles may be allowed if given approval.

Do not ride on the California type profilograph.

Complete initial runs of the profilograph before opening the new pavement to public traffic whenever practical. Only flagging costs for traffic control required for the initial running of the profilograph will be paid for according to Section 624.

Submit the profile graphs immediately thereafter for evaluation. Label profile graphs as directed. A profile index will be calculated for each 0.1 km (0.1 mi) of traffic lane measured according to Test Method No. Nev. T446.

The pavement smoothness type (Type A, B, or C) will be specified in the Special Provisions. The maximum allowable profile index for each km (mi) section and 0.1 km (0.1 mi) section for the specified pavement type shall be as follows:

| Pavement Smoothness Type | PROFILE INDEX mm/km (in./mi) | mm/0.1 km (in./0.1 mi) |
|---|---|---|
| Type A | 80 (5) | 8 (0.5) |
| Type B | 110 (7) | 11 (0.7) |
| Type C | 160 (10) | 16 (1.0) |

Pavement on horizontal curves having a centerline radius of 300 m (1,000 ft) or more, but less than 600 m (2,000 ft), and within the superelevation transition of such curves will be evaluated as pavement smoothness Type C.

Grind areas exceeding the profile index requirements and areas representing high points on the profiles having deviations in excess of 7.5 mm (0.3 in.) as measured according to Test Method No. Nev. T446. Remeasure ground areas for conformance with the profile index and for no high points in excess of 7.5 mm (0.3 in.).

Perform additional grinding as necessary to extend the ground area laterally to the nearest lane line or edge of pavement and longitudinally to lines normal to the pavement centerline.

Correct deviations in excess of 7.5 mm (0.3 in.) that cannot be brought into specified surface tolerances by abrasive grinding, by removal and replacement, or by placing an overlay of hot mix asphalt. Obtain approval of the exact method of correction.

Apply seal coat to ground areas after the surface tolerance specifications have been met. Apply the seal coat according to Section 407.

The grinding machine for correcting pavement exceeding the profile requirements shall be power driven, self-propelled and specifically designed to remove, profile, smooth, and texture hot mix asphalt. Use grinding machine with a wheel base of not less than 3.6 m (12 ft), equipped with a rotating powered mandrel drum studded with diamond blades with a cutting head not less than 0.9 m (3 ft) wide. Equip the grinding machine with an effective means for controlling dust and other particulate matter.

Do not cause strain or damage to the underlying surface of the pavement with the grinding machine. Do not use grinding and texturing equipment that causes ravels, aggregate fractures, spalls, or disturbance of joints.

Perform grinding in a longitudinal direction. Satisfactorily grind to produce a uniform textured surface over the surface areas designated for grinding.

The surface of the ground pavement shall have parallel corduroy-type texture consisting of grooves between 2.3 mm (0.09 in.) and 3.3 mm (0.13 in.) wide. The peaks of the ridges shall be approximately 1.5 mm (1/16 in.) higher than the bottom of the grooves with approximately 170 to 190 evenly spaced grooves per meter (52 to 57 grooves per foot).

Pick up and dispose of grinding materials, including water used for the grinding operation, outside the right of way according to Subsection 107.14.

**402.03.06 Compaction.** Perform compaction according to one of the following methods of compaction. The required method of compaction will be specified in the Special Provisions.

(a) Standard Rolling Pattern (Method A). Use rollers conforming to Subsection 401.03.04.

Perform initial or breakdown rolling with 2 complete coverages of the mat with a steel wheel roller.

Follow the initial rolling by intermediate rolling with a minimum of 3 complete coverages with a pneumatic tired roller.

A complete coverage is defined as a roller pass forward and back within a given area.

Perform finish rolling with a 2 axle tandem steel wheel roller.

Modify rolling pattern as directed.

(b) Test Section (Method B). Use rollers conforming to Subsection 402.03.02.

Compaction of the bituminous mixture will be evaluated by means of test sections as hereinafter described.

Each lift of each course of bituminous material will be divided into "Test Sections." Each test section shall have an area not to exceed 5,500 $m^2$ (6,600 $yd^2$). After 2 days of production, the test section size may be increased to a maximum of 11,000 $m^2$ (13,000 $yd^2$), if specified densities are being obtained. If any test section fails the density requirements, the 5,500 $m^2$ (6,600 $yd^2$) maximum shall again be used.

1. Compaction Requirements of Test Sections. The density of each test section will be evaluated based on the results of 5 nuclear tests taken at randomly selected locations within the sections as described in Test Method No. Nev. T335. The mean density of the 5 nuclear tests shall not be below 92% nor above 96% (with no single test below 90% nor above 97%) of the "Target" density achieved in the Department's Field Laboratory using Test Method No. Nev. T324.

Joint compactions will be taken adjacent to the randomly selected density locations specified herein. Construct longitudinal joints with a minimum density of 90% of the target density.

Upon completion of the first test section and after the material has cooled sufficiently, drill a core from each of the 5 locations where the nuclear tests were taken. The density of these cores will be determined by Test Method No. Nev. T336. The average of these 5 core densities will be correlated to the average of the 5 nuclear densities according to Test Method No. Nev. T335. Once this correlation procedure has been completed, the nuclear testing device (described in Test Method No. Nev. T335) will be used to determine densities of subsequent test sections.

If the correlation between the nuclear device and the cores has changed, the correlation procedure may be repeated.

Drill cores for each successive lift on the first day of each lift and provide to the Engineer for correlating the Nuclear Testing Device.

If the mean density of the test section or any individual test density falls below the foregoing requirements, remove failing section and take action to correct procedures. Limit paving operations to 4 hours per day until suitable procedures indicate that the density specification is being obtained.

If procedures are no longer achieving acceptable results, a change in the compaction equipment and/or methods may be requested.

2. Compaction Requirements for Small Sized Areas. In cases where the test section size cannot be as specified above, the compaction will be accepted on the basis of a single test for every 1,000 $m^2$ (1,000 $yd^2$) of area or fraction thereof. The individual test density shall be at least 90% of the target density.

(c) Control Strip (Method C). Use rollers conforming to Subsection 402.03.02.

Each lift of each course of bituminous material will be divided into "Control Strips" and "Test Sections." Each control strip shall have an area of at least 350 $m^2$ (400 $yd^2$), and shall be of the same depth to be used in the test sections. Each test section shall have an area not to exceed 5,500 $m^2$ (6,600 $yd^2$). After two days of production the test section size may be increased to a maximum of 11,000 $m^2$ (13,000 $yd^2$), if specified densities are being obtained. If any test section fails the density requirements, the 5,500 $m^2$ (6,600 $yd^2$) maximum shall again be used.

1. Construction of Control Strips. Construct control strips using the same procedures and on the same base material to be used in the construction of the remainder of the work. Use the same type, mass, and sequence of rollers on the control strips as will be used to compact the test sections.

Construct one control strip at the beginning of work on each lift of each roadway course. Construct an additional control strip when a change is made in the type or source of material or whenever a significant change occurs in the composition of the material (including any significant change in mix design such as bitumen ratio, gradation, void content, etc.) A new control strip will be required when 10 test sections have been constructed without establishment of a new control strip.

Compact the control strip. Continue rolling until no appreciable increase in density is obtained by additional roller coverages.

Upon completion of the rolling, the mean density of the control strip will be determined by taking 10 tests at randomly selected locations within the control strip area as described in Test Method No. Nev. T750. Compaction of successive test sections shall be governed by the mean density obtained in the control strip.

Approved control strips are to remain in place and become a section of the completed roadway. Control strips shall be subject to the same surface tolerance requirements as the remainder of the work.

2. Compaction Requirements of Test Sections. The density of each test section will be evaluated based on the results of 5 tests, performed at randomly selected locations within the test section as described in Test Method No. Nev. T750. The mean density obtained for the 5 tests shall be at least 98% of the mean density obtained in the approved control strip. Each individual test value obtained shall be at least 95% of the mean density obtained in the approved control strip.

If the mean density of a test section does not conform to the 98% requirement, continue the compactive effort on the entire test section until the required mean density is obtained. If an individual test value does not conform to the 95% requirement, continue the compactive effort on the area represented by that test until the required density is obtained.

3. Compaction Requirements for Small Sized Areas. In cases where the test section size cannot be as specified above, the compaction will be accepted on the basis of a single test for every 1,000 $m^2$ (1,000 $yd^2$) of area or fraction thereof. The individual test density shall be at least 95% of the mean density of the approved control strip.

## METHOD OF MEASUREMENT

**402.04.01 Measurement.** Plantmix surfacing, plantmixing miscellaneous areas, and plantmix bituminous shoulder dikes will be measured as specified in Subsection 401.04.01.

## BASIS OF PAYMENT

**402.05.01 Payment.** The accepted quantities, measured as provided above, will be paid for at the contract price per unit of measurement for the pay items listed below that are shown in the proposal. Payment will be full compensation for the work prescribed in this Section.

Payment will be made under:

| Pay Item | Pay Unit |
|---|---|
| Plantmix Surfacing (type) (Wet) | Metric Ton (Ton) |
| Plantmixing Miscellaneous Areas | Square Meter (Square Yard) |
| Plantmix Bituminous Shoulder Dikes | Linear Meter (Linear Foot) |

# SECTION 403

## PLANTMIX BITUMINOUS OPEN–GRADED SURFACE

### DESCRIPTION

**403.01.01 General.** This work consists of placing plantmix bituminous open-graded surface.

This work also consists of constructing milled rumble strips in the plantmix bituminous open-graded surface and other pavement surfaces.

### MATERIALS

**403.02.01 General.** Material shall conform to the following Subsections:

General ..... Subsection 401.02.01
Composition of Mixtures ..... Subsection 401.02.02

### CONSTRUCTION

**403.03.01 General.** The construction requirements shall conform to Subsections 401.03.01 through 401.03.13, inclusive, with the exceptions contained in the following Subsections.

**403.03.02 Rollers.** Operate with each paver a breakdown and finish roller as specified in Subsection 401.03.04.

**403.03.03 Joints.** Construct longitudinal joints only on the shoulders, or at the edge of travel lanes.

**403.03.04 Surface Tolerances.** Produce completed surfacing which meets the straightedge and profilograph requirements of Subsection 402.03.05 with the following additions and exceptions to the profilograph measurement.

The pavement smoothness type (Type A, B, or C) will be specified in the Special Provisions.

Furnish a profilograph meeting the requirements of Subsection 402.03.03 and operate the profilograph as specified in Subsection 402.03.05, at the time and date ordered. Painted marks on the open-graded surface, as specified in Subsection 402.03.05, shall not exceed 20 $cm^2$ (4 $in.^2$).

Include 10 m (30 ft) of the existing pavement on each end of the project in the profile determination. Make construction joints with the existing pavement meet the requirements of this Subsection.

Repair or remove and replace all areas exceeding the profile index requirements and areas representing high points on the profiles having deviations in excess of 10 mm (0.4 in.) as measured according to Test Method No. Nev. T446. Remeasure repaired or replaced areas for conformance with the profile index and for no high points in excess of 10 mm (0.4 in.).

Grinding may be utilized for repair to the open-graded surface when approved. Limit ground areas to 7.6 m (25 ft) in length. The grinder and grinding operation shall conform to Subsection 402.03.05.

Perform additional grinding as necessary to extend the ground area laterally to the nearest lane line or edge of pavement and longitudinally to lines normal to the pavement centerline.

Apply a seal coat to ground areas after the surface tolerance specifications have been met. Apply the seal coat according to Section 407.

**403.03.05 Spreading and Finishing.** Place the material in a windrow in front of the spreading and finishing machine.

**403.03.06 Preparation of Aggregates.** Before the introduction of mineral filler, add sufficient moisture to bring the aggregates to a moisture content where enough free surface moisture is available to thoroughly wet the aggregate and activate the lime. The actual amount of moisture required shall be as approved.

**403.03.07 Milled Rumble Strips.** Mill the rumble strips to the dimensions shown in the plans. Use a milling machine that produces a reasonably smooth cut surface with 2 mm (0.08 in.) maximum differentials between peaks and valleys.

Locate the rumble strips as shown in the standard plans, unless the location has been modified by the contract plans. The alignment of the edge of the milled pattern will be randomly checked. Re-cut any rumble strip which is misaligned.

Some of the shoulders designated for receiving the rumble strips may have widths of approximately 0.6 m (2 ft) from the shoulder stripe to a vertical obstruction of concrete barrier rail or guardrail. There will be no additional compensation for any additional special milling machine necessary to install rumble strips at these locations.

Demonstrate on an initial 150 m (500 ft) test section that the equipment and method will provide the desired milled rumble strip and surface inside each depression without tearing or snagging the asphalt pavement. If the desired results are not being provided, provide new equipment, new method, or make necessary adjustments to provide the desired results. If the initial 150 m (500 ft) test section is unacceptable, repair the surface as directed, make necessary adjustments and retest.

Use a power broom or sweeper/vacuum to remove waste material resulting from the operation each day. The milled waste material may also be broomed and uniformly spread on the roadway side slopes at the end of each day's operations.

**403.03.08 Compaction.** Perform compactive rolling with a minimum of 2 complete coverages of the mat, by each roller, or as directed. A complete coverage is defined as a roller pass forward and back within a given area.

## METHOD OF MEASUREMENT

**403.04.01 Measurement.** Plantmix open-graded surfacing will be measured as specified in Subsection 401.04.01.

## BASIS OF PAYMENT

**403.05.01 Payment.** The accepted quantities, measured as provided above, will be paid for at the contract price per unit of measurement for the pay items listed below that are shown in the proposal. Payment will be full compensation for the work prescribed in this Section.

Payment will be made under:

| Pay Item | Pay Unit |
|---|---|
| Plantmix Open-Graded Surfacing [*.....mm (in)] (Wet) | Metric Ton (Ton) |
| Milled Rumble Strips | Kilometer (Mile) |

* Aggregate size in Subsection 705.03.02, and as indicated in the proposal.

# SECTION 404

## COLD RECYCLED BITUMINOUS SURFACE AND PREMIXED BITUMINOUS PAVING MATERIAL

DESCRIPTION

**404.01.01 General.** This work consists of preparing and placing recycled bituminous surface and furnishing, stockpiling, loading, hauling, and placing premixed bituminous paving material.

MATERIALS

**404.02.01 Composition of Cold Recycled Mixtures.** Compose the recycled bituminous mixture of reclaimed asphalt pavement, a recycling agent, and lime slurry, as specified.

(a) Gradation. Produce cold milled bituminous surface material, to be used in the recycling process, conforming to the following gradation requirements:

| Sieve | Percent Passing by Mass |
|---|---|
| 31.5 mm (1.25 in.) | 100 |

Separate cold milled bituminous material larger than 31.5 mm (1.25 in.) by screening or other means, break down by mechanical means to pass a 31.5 mm (1.25 in.) sieve and uniformly incorporate into the recycled mixture.

(b) Recycled Material. The recycled asphalt mixture shall consist of milled material from the existing pavement, recycling agent, and lime slurry combined in the proportions specified herein, or as directed.

(c) Recycling Agent. Add recycling agent to the cold milled material at an estimated rate of 1.5% by mass of the milled material. The actual application rate will be established in the field. Adjust the recycling agent application rate, with concurrence from the Engineer, as pavement conditions change. The request to adjust the application rate should be based on the opinion of a knowledgeable and experienced individual who works for the Contractor. The adjusted application rate shall be between 1.25% and 1.75% by mass of the milled material. If raveling or rutting of the cold recycled material occurs before the overlay is placed, take corrective measures and repair the cold recycled surface at own expense.

The Department reserves the right to increase the application rate of recycling agent. In this case, the Department will accept any potential risk associated with the performance of the recycle mat caused by increasing the recycling agent.

The type and grade of recycling agent will be specified in the contract. The recycling agent shall meet the applicable requirements of Section 703. For field test acceptance, refer to Subsection 408.02.02. Submit a 3.75 L (1 gal) sample of the recycling agent for approval at least 14 days before commencing recycle operations.

In lieu of furnishing a sample of bituminous material, a passing test report may be submitted which has been previously issued by the Department's Materials Division. The report shall be from the current calendar year. The material type and producer shall be the same as that to be utilized on the project.

Add recycling agent to the cold milled material and mix to a homogeneous and uniformly coated mixture. Mix recycling agent in accordance with the temperature requirements of Subsection 406.03.04.

(d) Additives. Introduce hydrated lime slurry into the cold milled material. Produce the hydrated lime slurry at the job site and introduce as specified below. Prepare lime slurry containing 1.5% calcium oxide (quicklime) by mass of the milled material conforming to the quicklime specification in ASTM C977.

Use water in the slaking operation conforming to Section 722.

Submit batch logs and solids content information for each batch.

**404.02.02 Composition of Premixed Bituminous Paving Material.** Compose the premixed bituminous paving material of aggregates, bituminous material, and mineral filler.

The type and grade of bituminous material and type of aggregate will be specified in the contract.

Submit samples of the aggregate and cutback asphalt for the mix design according to Subsection 401.02.02.

Aggregates shall meet the requirements of Section 705, for the grading size and type specified. Bituminous material shall meet the applicable requirements of Section 703. Mineral filler shall conform to Subsection 705.03.03.

Mix the aggregate, bituminous material, and mineral filler in proportions conforming to the mix design and according to the (a) Plantmixing Method of Subsection 404.03.06.

CONSTRUCTION

**404.03.01 Cold Recycle Equipment.** Use equipment specifically designed for production of lime slurries.

Introduce the lime slurry at the mill head, as directed, by mass of the cold milled material. Calculate the mass of the cold milled material by kg/m$^3$ (lb/ft$^3$) for volume of cut. Use a metering device to accurately measure the amount of lime slurry required to within plus or minus 5%. Lime slurry rate of application shall be tied to the forward speed of the milling machine.

Use agitators or similar equipment to keep the hydrated lime slurry in suspension when held in the lime slurry feed tank.

Keep the hydrated lime slurry in suspension during transport using similar agitator equipment.

The recycling train shall consist of a milling machine, crusher, and a pugmill mixer.

Provide a milling machine which meets the requirements of Subsection 202.03.03 with the exception that the rotating powered mandrel drum shall be operated in the up-cut direction and studded with conical tungsten carbide tipped bits that produce a textured surface consisting of parallel ridges and furrows resembling a corrugated pattern. Horizontal spacing of the parallel ridges shall not be less than 15 mm (5/8 in.) or greater than 22 mm (7/8 in.). The depth of the furrows shall not be less than 6 mm (1/4 in.) and not more than 13 mm (1/2 in.).

Perform the cold milling operation in a manner that ensures the underlying material is not damaged. The primary milling machine shall have a minimum 3.6 m (12 ft) cutter capable of removing the existing pavement to the depths shown in the plans. A smaller milling machine may be used to mill the shoulders and miscellaneous areas. Provide a primary milling machine capable of discharging lime slurry on the cutting heads.

The use of a heating device to soften the pavement will not be permitted.

Use a portable crusher capable of reducing the oversize recycled materials to the specified size.

Equip a portable continuous pugmill mixing plant with a belt scale and automatic controls to obtain the proper amount of recycling agent. Provide a pugmill which meets the requirements of Subsection 401.03.01.

Equip the recycling train with positive displacement pumps and a computerized metering system which can accurately meter the amount of recycling agent. Provide an interlocked computerized belt weighing system that measures the quantity of recycled material entering the mixing plant. Design the interlock so that recycling agent cannot be added until the recycled material enters the mixer. Equip overrides of the interlock system with short duration timers to prevent their continuous use. Use overrides only during start-up periods.

Provide facilities to verify and calibrate the aggregate weigh system, recycling agent metering device, and lime slurry metering device.

Calibrate the aggregate weigh system, recycling agent metering device, and lime slurry metering device before beginning recycling operations, no less than once a year, and any other time as directed.

Calibration of the aggregate weigh system shall conform to Subsection 401.03.01 (4.c) with the exception that marinated material is not required.

Calibration of the recycling agent metering device shall conform to Subsection 401.03.01 (4.d).

Calibrate lime slurry metering device at two different speeds (lowest and highest speed of anticipated operation) in relation to the speed of the aggregate feed using the percentage of lime slurry set forth in the contract documents or as approved. Provide platform scales with a Certificate of Inspection as required in Subsection 109.01.

Furnish a vessel having a sufficient capacity to perform the calibration testing. A minimum of 3,785 L (1,000 gal) shall be the required amount for a valid test. Calibrate the lime slurry feed so the masses shown on the metering device are within ± 5% of the weighed mass.

Do not begin recycling operations until calibration procedures have been observed and approved. Do not operate outside the parameters of the equipment calibration limits during recycling operations.

Have readouts for the belt weighing device and computerized metering system that indicate the quantity in metric tons (tons) of recycled material and recycling agent being fed into the mixer at any given time. Provide totalizer readouts to allow determination of accumulative quantities of each constituent.

**404.03.02 Pavers.** Use a paver meeting the requirements of Subsection 401.03.03 and with a minimum power of 127 kW (170 hp) to place cold recycled mixtures to establish grade and cross slope.

**404.03.03 Rollers.** Provide a minimum of one pneumatic tired roller with an operating weight of at least 13.6 metric tons (15 tons) and not more than 18.1 metric tons (20 tons). Provide a minimum of one pneumatic tired roller with an operating weight of at least 22.7 metric tons (25 tons) and not more than 27.2 metric tons (30 tons). Provide a minimum of two double drum vibratory steel wheeled rollers weighing at least 9.1 metric tons (10 tons). Use rollers in good condition with an operational, working water system.

Use a combination of steel wheeled, under static or vibratory mode, and pneumatic tired rollers to establish a rolling pattern with the appropriate combination of rollers and number of passes that will provide maximum compaction without cracking the recycle mat. Do not compact outside the edge of the existing pavement width limits to prevent roadway spread.

**404.03.04 Weather Limitations.** Do not begin in-place recycling until pavement surface temperature is 16 °C (60 °F) and rising and the atmospheric temperature in the shade is 10 °C (50 °F) and rising. Do not begin in-place recycling if it is anticipated the atmospheric temperature will drop below 2 °C (35 °F) within 48 hours of mixing, or during stormy weather. Consider weather stormy when the rate of precipitation exceeds the rate of evaporation.

Stop recycling operations a minimum of 3 hours before sunset to allow completion of initial compaction while surface temperature is 16 °C (60 °F) or above.

If it rains on the recycled surface during the overlay operation, suspend the paving operation. The Engineer will take 3 randomly selected samples from the recycled surface to be overlaid a minimum of 2 hours after it rains. If the average moisture content of the samples is 2.0% or less as determined by Test Method No. Nev. T112, proceed with paving. If the average moisture content is greater than 2.0%, delay paving for a minimum of 72 hours or until the average moisture content from 3 more samples is 2.0% or less.

**404.03.05 Repair of Failed Pavement Subgrade Areas.** Repair failed pavement subgrade areas encountered during the recycling operations as directed. Perform repairs before the limits of the failed areas increase in size. Work will be immediately suspended if the limits of the failed areas increase. When suspension occurs, repair the failed areas before any other operation proceeds. Working days will continue to be assessed during the suspension period. The repaired areas will be paid for according to Subsection 109.03. If the designated areas are not repaired before the areas increase in size, make repairs to the expanded failed pavement subgrade areas at no cost to the Department.

Repair the failed pavement subgrade areas by excavating to a depth of 450 mm (18 in.) and place a structural section of 300 mm (12 in.) of Type 1 Class B Aggregate Base and 150 mm (6 in.) of dense-graded plantmix bituminous surface. If dense graded plantmix is not available, place premixed bituminous surfacing as a temporary patch until dense graded plantmix becomes available. Remove and replace the premixed bituminous surfacing with dense graded plantmix.

**404.03.06 Mixing.** (a) Plantmixing Method. Mix the aggregate with the cutback asphalt at a central mixing plant according to Subsection 401.03.01. If the moisture content of the aggregate is 2% or less by mass of the dry aggregate, as determined by Test Method No. Nev. T112, mixing of the materials without passing the aggregate through a dryer will be permitted.

Add mineral filler according to Subsection 401.03.08, Marination Method.

(b) Recycling Train. Combine the milled material, recycling agent, and lime slurry in the specified quantities or as directed. Continue mixing until the recycling agent and lime slurry have been distributed uniformly.

**404.03.07 Spreading, Compacting, and Finishing.** Except for unavoidable delay or breakdown, recycle and place recycled pavement, with a paving machine meeting the requirements of Subsection 404.03.02, at a rate sufficient to provide continuous operation of the paving machine. If paving operations result in excessive stopping of the paving machine, suspend recycling and paving operations until the synchronization of the rate of recycle with the capacity of the paving machine can be attained.

Place the recycled mixture on the roadbed in front of the paver in a consistent windrow.

Remove, by hand, and dispose of all visible oversized crack filler in the cold recycled material windrow.

Use windrow equipment capable of removing and loading all of the recycled mixture into the spreading and finishing machine.

Lay the recycled mixture on the surface, spread and strike off to established grade and elevation.

After the cold recycled mixture has been spread and surface irregularities have been corrected, delay breakdown rolling for 1 to 2 hours. Thoroughly and uniformly compact the recycled mixture to the required density without undue displacement or cracking. Prevent excessive edge sloughing by compacting the longitudinal joint first followed by initial passes that shall begin on the low side and progress to the high side by overlapping longitudinal passes parallel to the pavement centerline. The recycled surface will be visually inspected for approval.

Apply an emulsified asphalt (diluted) fog seal to the recycled mixture. Following the fog seal, apply a sand blotter. The fog seal shall be a mixture of 50% recycling agent and 50% added water by mass. Mix the recycling agent and added water according to Subsection 405.02.01.

Do not turn hauling equipment in areas where such turning may result in tearing, gouging, or distortion of the previously laid pad of recycled material. Immediately repair any damage at no cost to the Department.

After initial compaction, and before recompaction, open the recycled mixture to public traffic and allow the mixture to cure a minimum of 10 days before overlaying. Perform recompaction between 3 and 15 days after initial compaction or as directed. Do not perform rolling when the surface temperature is below 32 °C (90 °F).

Recompact the entire recycled pavement area with at least one steel wheeled roller weighing at least 9.1 metric tons (10 tons), in the static mode, and one pneumatic roller weighing at least 22.7 metric tons (25 tons).

Compaction of the recycled pavement will be evaluated in accordance with Subsection 402.03.06, (c) Control Strip (Method C).

If procedures are no longer achieving acceptable results, a change in the compaction equipment and/or methods will be required.

Correct any displacement of the mat, regardless of thickness, occurring as a result of the reversing of the direction of a roller, or from other causes. Moisten steel roller wheels with water to the least extent necessary to prevent pickup.

When the rolling causes undue tearing, displacement, cracking or shoving, make changes in compaction equipment and/or rolling procedures to alleviate the problem.

Construct joints in accordance with the requirements of Subsection 401.03.12. Keep the longitudinal joints free of loose material. Overlap the cold milled longitudinal joints a minimum of 100 mm (4 in.) when making adjacent recycling passes.

**404.03.08 Surface Tolerances.** The top surface of the completed recycled pavement will be tested with a 3.6 m (12 ft) straightedge parallel to, and perpendicular to, the centerline and shall not vary by more than 6 mm (1/4 in.) from the lower edge of the straightedge.

**404.03.09 Conditions of Acceptance and Corrective Actions for Cold Recycle Mixture.** Acceptance for payment of the cold recycle will be by visual inspection of the mixture on the roadway following initial rolling and recompaction requirements. Correct any mixture not uniformly mixed or that ravels as follows:

(a) Reprocess or replace any area showing an excess or a deficiency of emulsified asphalt.

(b) If raveling occurs, immediately provide traffic control and additional rolling. Repair the recycled surface before proceeding with any other work.

Reprocess or repair by approved methods, at own expense. Repair any damage before overlaying.

When tests show the recycled surface is not within the specified tolerance, take immediate action to correct equipment or procedures in the paving operation to eliminate the unacceptable pavement roughness.

Remove all cold patches larger than 2 $m^2$ (20 $ft^2$) and replace with hot mix prior to dense-graded overlay.

**404.03.10 Premixed Bituminous Paving Material.** Clear the stockpile area of all brush, rubbish and deleterious matter.

The premixed bituminous paving material is to be stockpiled at an exact location and in a manner as directed before the start of any cold recycling, roadbed modification, crack and seating or any other operation that may require the use of the premixed bituminous paving material to repair the surface.

Place the premixed bituminous paving material, when directed, for making necessary repairs to the roadway surface.

## METHOD OF MEASUREMENT

**404.04.01 Measurement.** Recycled Bituminous Surface (depth) will be measured by the square meter (square yard). No measurement will be made for overlap at longitudinal joints.

Lime (Cold Recycle) will be measured by the metric ton (dry ton).

Bituminous material will be measured by the metric ton (ton).

Emulsified asphalt (diluted) will be measured by the metric ton (ton) of diluted mixture.

Sand blotter will be measured and paid for according to Section 407.

Premixed bituminous paving material will be measured by the metric ton (ton) or cubic meter (cubic yard) of completed mixture of aggregate, mineral filler, and bituminous material in stockpile.

Haul and place premixed bituminous paving material will be measured by the metric ton (ton), square meter (square yard) or cubic meter (cubic yard), of the completed mixture acceptably placed and compacted on the roadbed.

When haul and place premixed bituminous paving material is to be measured by the force account basis, measurement will be made according to Subsection 109.03.

## BASIS OF PAYMENT

**404.05.01 Payment.** The accepted quantities, measured as provided above, will be paid for at the contract price per unit of measurement for the pay items listed below that are shown in the proposal. Payment will be full compensation for the work prescribed in this Section.

Payment will be made under:

| Pay Item | Pay Unit |
|---|---|
| Recycled Bituminous Surface (depth) | Square Meter (Square Yard) |
| Lime (Cold Recycle) | Metric Ton (Ton) |
| Emulsified Asphalt (type) | Metric Ton (Ton) |
| Cutback Asphalt (grade) | Metric Ton (Ton) |
| Premixed Bituminous Paving Material | Metric Ton (Ton), Cubic Meter (Cubic Yard) |
| Haul and Place Premixed Bituminous Paving Material | Metric Ton (Ton), Square Meter (Square Yard), Cubic Meter (Cubic Yard), Force Account |

# SECTION 405

## TACK COAT

DESCRIPTION

**405.01.01 General.** This work consists of applying a bituminous material tack coat.

MATERIALS

**405.02.01 Bituminous Material.** The bituminous material shall conform to the applicable requirements of Section 703.

Emulsified asphalt for the tack coat shall be Emulsified Asphalt, Type SS-1h (Diluted); however, Emulsified Asphalt, Type SS-1 (Diluted), Emulsified Asphalt, Type CSS-1 (Diluted), Emulsified Asphalt, Type CSS-1h (Diluted) or Emulsified Asphalt, Type CQS-1nv (Diluted) may be substituted.

Emulsified asphalt (diluted) shall be a mixture of 70% emulsified asphalt and 30% added water by mass. To accomplish this mixing, fill the distributor partly with water, and then add the emulsified asphalt. Spray the remaining required water into the tank under pressure and then thoroughly circulate within the distributor.

CONSTRUCTION

**405.03.01 Equipment.** Equipment for heating and applying the emulsified asphalt shall meet the following requirements:

(a) Capable of heating asphalt evenly.

(b) Power unit for the pump, and full circulation spray bar adjustable to 4.3 m (14 ft) wide.

(c) Positive controls including tachometer, pressure gages, volume measuring device, and calibrated tank, to uniformly apply asphalt within 0.10 L/m$^2$ (0.02 gal/yd$^2$) of the required rate.

(d) Thermometer for measuring temperatures in the tank.

(e) Use the correct size nozzles and application pressure for the type and grade of asphalt and speed of distributor. Nozzles shall be free from damage, unclogged, and freely spraying. Nozzles shall be uniformly angled from spray bar such that the spray fans do not interfere with other spray fans. Special end-nozzles or shields installed on the end of the spray bar shall be adjusted to provide clean, uniform application and edges without streaks. Adjust and maintain the spray bar height to provide uniform double or triple lap coverage of bituminous material spread while preventing wind or other distortion.

**405.03.02 Weather Limitations.** Do not apply emulsified asphalt when the surface to be treated is damp, wet, when weather conditions are unsuitable, or when the atmospheric or surface temperature is below 4 °C (40 °F).

**405.03.03 Preparation of Surface.** Patch and clean the surface and remove any irregularities from the surface. Clean the edges of existing pavements which are to be adjacent to new pavement. See Subsection 105.15.

**405.03.04 Application of Bituminous Materials.** Apply emulsified asphalt tack coat on surfaces to receive paving and between all paving courses unless otherwise directed.

The temperature of the emulsified asphalt shall conform to Subsection 406.03.04.

Uniformly apply the emulsified asphalt to the surface, including any adjacent vertical edges.

Apply the emulsified asphalt in such manner as to offer the least inconvenience to traffic and to permit one-way traffic without pickup or tracking of the bituminous material. Place the covering course over tack that is clean, free of tracking and adequately set.

Do not apply more tack than can be covered in the same shift.

## METHOD OF MEASUREMENT

**405.04.01 Measurement.** Tack coat will be measured to confirm that application rates meet the contract requirements.

## BASIS OF PAYMENT

**405.05.01 Payment.** No direct payment will be made for the work prescribed in this Section. Compensation shall be considered as included in the contract unit prices bid for the particular items requiring tack coat.

# SECTION 406

## PRIME COAT

### DESCRIPTION

**406.01.01 General.** This work consists of applying a bituminous material prime coat and sand blotter as required.

### MATERIALS

**406.02.01 Bituminous Material.** The type and grade of bituminous material will be specified in the contract. The bituminous material shall meet the applicable requirements of Section 703.

Approved products listed on the QPL may be substituted for the material specified.

**406.02.02 Sand Blotter.** Sand blotter shall meet the requirements of Subsection 705.03.05. The material may be accepted in stockpile at the source.

### CONSTRUCTION

**406.03.01 Equipment.** Equipment for heating and applying the bituminous material shall meet the requirements of Subsection 405.03.01.

**406.03.02 Weather Limitations.** Do not apply bituminous material on a wet surface, when the atmospheric temperature is below 10 °C (50 °F), or when weather conditions would prevent the proper construction of the prime coat.

**406.03.03 Preparation of Surface.** The surface shall conform to the established lines and grades, and be smooth and uniform. Compact surface to the required density. If required, recompact to the required density. If required, apply water immediately before the bituminous application.

**406.03.04 Application of Bituminous Material.** Uniformly apply the bituminous material in a continuous spread. Treat not more than half of the width of the section when traffic is maintained. Carefully apply bituminous material at the junctions of spreads so that it is not in excess of the specified amount. Squeegee excess bituminous material from the surface. Correct skipped or deficient areas.

One way traffic may be permitted on the untreated portion of the roadbed. Transfer traffic to the treated portion when the bituminous material has been absorbed by the surface and will not pick up.

Allow prime coats to cure for a minimum of 48 hours prior to paving, unless otherwise approved.

The temperature of the bituminous materials shall conform to the requirements of Table I.

**TABLE I**

**SPRAYING AND MIXING TEMPERATURES OF CUTBACK ASPHALTS**

| Grade and Type MC and SC | Distributor Spraying Temperature °C (°F) | | * Pugmill Mixing Temperature of Cutback Asphalts and Aggregates °C (°F) | |
|---|---|---|---|---|
| | Minimum | Maximum | Minimum | Maximum |
| 70, 70NV | 49 (120) | 82 (180) | 35 (95) | 60 (140) |
| 250 | 74 (165) | 104 (220) | 57 (135) | 79 (175) |
| 800 | 93 (200) | 124 (255) | 74 (165) | 96 (205) |
| 3000 | 113 (235) | 143 (290) | 93 (200) | 116 (240) |

* The maximum spraying temperature may be used if the aggregate is not heated.

**SPRAYING AND MIXING TEMPERATURES OF EMULSIFIED ASPHALTS**

| Grade of Emulsified Asphalt | Distributor Spraying Temperature °C (°F) | | * Pugmill Mixing Temperature of Emulsions and Aggregates °C (°F) | |
|---|---|---|---|---|
| | Minimum | Maximum | Minimum | Maximum |
| CRS-2nv | 52 (125) | 85 (185) | (Not used for Mixing) | |
| CQS-1nv | 21 (70) | 71 (160) | (Not used for Mixing) | |
| SS-1, CSS-1 | 21 (70) | 71 (160) | 10 (50) | 71 (160) |
| SS-1h, CSS-1h | 21 (70) | 71 (160) | 10 (50) | 71 (160) |
| CMS-2s, CQS-1h | 21 (70) | 71 (160) | 10 (50) | 71 (160) |
| LMCRS-2h | 52 (125) | 85 (185) | (Not used for Mixing) | |
| PMPS, PMPS-h | 43 (110) | 85 (185) | (Not used for Mixing) | |
| PMPS-QB, PMPS-FS | 43 (110) | 85 (185) | (Not used for Mixing) | |
| MSE, MSE-h | (Not used for Spraying) | | 21 (70) | 71 (160) |

* The maximum spraying temperature may be used if the aggregate is not heated.

**406.03.05 Application of Blotter Material.** When necessary for traffic, spread blotter material in the amounts required to absorb any excess bituminous material.

## METHOD OF MEASUREMENT

**406.04.01 Measurement.** Bituminous material will be measured by the metric ton (ton) based on the use of the material specified in the contract. If electing to use alternate approved products from the QPL it shall be at no additional cost to the Department. The Department will determine the quantity of alternate product measured for payment.

Sand blotter will be measured by the metric ton (ton) or cubic meter (cubic yard).

## BASIS OF PAYMENT

**406.05.01 Payment.** The accepted quantities, measured as provided above, will be paid for at the contract price per unit of measurement for the pay items listed below that are shown in the proposal. Payment will be full compensation for the work prescribed in this Section.

When sand blotter is not included in the proposal and it is needed to protect the work or public traffic, payment will be made according to Subsection 104.03.

Payment will be made under:

| Pay Item | Pay Unit |
|---|---|
| Cutback Asphalt (type) | Metric Ton (Ton) |
| Emulsified Asphalt (type) | Metric Ton (Ton) |
| Sand Blotter | Metric Ton (Ton), Cubic Meter (Cubic Yard) |

# SECTION 407

## SEAL COAT

DESCRIPTION

**407.01.01 General.** This work consists of applying a bituminous material seal coat and sand blotter as required.

MATERIALS

**407.02.01 Bituminous Material.** The bituminous material shall conform to the applicable requirements of Section 703.

Unless otherwise specified, the bituminous material for the seal coat shall be Emulsified Asphalt, Type SS-1h (Diluted); however, Emulsified Asphalt, Type SS-1 (Diluted), Emulsified Asphalt, Type CSS-1 (Diluted), Emulsified Asphalt, Type CSS-1h (Diluted), or Emulsified Asphalt, Type CQS-1nv (Diluted) may be substituted. Regardless of the option chosen, emulsified asphalt will be measured and paid for under the bid item and at the contract unit price bid per metric ton (ton) for Emulsified Asphalt, Type SS-1h (Diluted) and no further compensation shall be allowed therefore.

Emulsified asphalt (diluted) shall be proportioned and mixed according to Subsection 405.02.01.

**407.02.02 Sand Blotter.** Sand blotter shall meet the requirements of Subsection 705.03.05. The material may be accepted in stockpile at the source.

CONSTRUCTION

**407.03.01 Equipment.** Equipment for heating and applying the bituminous material shall meet the requirements of Subsection 405.03.01.

**407.03.02 Weather Limitations.** Do not apply bituminous material on a wet surface, or when atmospheric temperature is below 10 °C (50 °F), or when weather conditions would prevent proper construction of the seal coat.

**407.03.03 Preparation of Surface.** Clean the entire width of surfacing of all dirt and loose material by sweeping with power brooms supplemented by hand brooms if necessary.

**407.03.04 Application of Bituminous Material.** Uniformly apply the bituminous material in one operation to the entire width of one designated traffic lane at a time.

The temperature of the bituminous material shall conform to Subsection 406.03.04.

Apply the seal coat in such manner as to offer the least inconvenience to traffic and to permit one-way traffic without pickup or tracking of the bituminous material.

When a surface treatment is to be applied to the travel lanes, apply the seal coat to the shoulder at least 4 days in advance of the application of the adjacent surface treatment requiring screenings. Apply in such a manner that the joint between the surface treatment and seal coat will present a neat and uniform appearance true to the line shown on the typical cross section.

Apply the seal coat over the surface treatment not sooner than 3 days, nor more than 7 days after completion of the final brooming as specified in Subsection 408.03.10.

**407.03.05 Application of Blotter Material.** When necessary for traffic, spread blotter material in the amounts required to absorb any excess bituminous material.

METHOD OF MEASUREMENT

**407.04.01 Measurement.** Bituminous material will be measured by the metric ton (ton).

Emulsified asphalt (diluted) will be measured by the metric ton (ton) of diluted mixture.

Sand blotter will be measured by the metric ton (ton) or cubic meter (cubic yard).

BASIS OF PAYMENT

**407.05.01 Payment.** The accepted quantities, measured as provided above, will be paid for at the contract price per unit of measurement for the pay items listed below that are shown in the proposal. Payment will be full compensation for the work prescribed in this Section.

When sand blotter is not included in the proposal and it is needed to protect the work or public traffic, payment will be made according to Subsection 104.03.

Payment will be made under:

| Pay Item | Pay Unit |
|---|---|
| Cutback Asphalt (type) | Metric Ton (Ton) |
| Emulsified Asphalt (type) | Metric Ton (Ton) |
| Sand Blotter | Metric Ton (Ton), Cubic Meter (Cubic Yard) |

# SECTION 408

## SURFACE TREATMENT

DESCRIPTION

**408.01.01 General.** This work consists of an application of bituminous material and cover of screenings applied on a previously compacted and bonded bituminous surface.

This work also consists of the production and stockpiling of screenings.

MATERIALS

**408.02.01 Bituminous Material.** The type and grade of bituminous material will be specified in the contract. The bituminous material shall meet the applicable requirements of Section 703.

Submit a 3.75 L (1 gal) sample of emulsified bituminous material for approval at least 14 days before use.

**408.02.02 Field Testing for Acceptance.** The Engineer reserves the right to selectively test emulsified bituminous materials for Saybolt Furol Viscosity at the job site or at any other designated area before application. Equip delivery trucks and trailers supplying emulsified bituminous materials with a sampling valve that provides a sample from the approximate mid-point of the load. Sample valves shall conform to AASHTO T40. If a sampling valve is not provided, samples may be obtained by the dip method according to Test Method No. Nev. T723. All samples are to be provided by the driver and the sampling process is to be observed by the Engineer. Sample bottles will be provided.

When tested for Saybolt Furol Viscosity, the specification limits contained in Subsection 703.03.04 will be used as the basis for using or rejecting the material and the demerit schedule for Saybolt Furol Viscosity will not apply. If the material fails to meet specification limits, a second test will be run on the same sample. If the second test also fails, the material represented by that sample will be rejected and returned to the supplier. No payment will be made for rejected material or for the shipping or handling thereof. Do not blend any rejected material. Samples representing material that is accepted for use on the project will be forwarded to the Department's Materials Division for further testing (excluding Saybolt Furol Viscosity tests) and the regular demerit schedule will apply.

**408.02.03 Screenings.** Screenings shall meet the requirements of Subsection 705.03.04, for the size specified.

Submit screenings for testing a minimum of 14 days before use.

CONSTRUCTION

**408.03.01 Distributors.** The distributor shall meet the requirements of Subsection 405.03.01. Calibrate the distributor for transverse and longitudinal application rates according to ASTM D2995 Test Method A or B, or other calibration method as approved. Verify calibration as directed.

**408.03.02 Aggregate Spreader.** The aggregate spreader shall be self-propelled and supported by at least 4 wheels equipped with pneumatic tires on 2 axles. Equip the aggregate spreader with positive control so that the required amount of material will be deposited uniformly over the full width of the bituminous material.

On divided highways, operate the aggregate spreader against the flow of traffic in order to allow the hauling trucks to enter and leave with the flow of traffic.

Calibrate the aggregate spreader according to ASTM D5624, or other calibration method as approved, at a rate to apply the quantity of cover aggregate as specified. Verify calibration as directed.

**408.03.03 Rollers.** On a new surface, operate with each aggregate spreader, two pneumatic tired rollers and one steel wheel roller. On an old surface, operate no less than three pneumatic tired rollers and no steel wheel rollers. The pneumatic tired roller shall meet the requirements of Subsection 401.03.04 (b). The steel wheel roller shall meet the requirements of the Subsection 401.03.04 (a) or (c).

Additional rollers may be required if the aggregate placement rate exceeds the capabilities of the initial rollers.

**408.03.04 Weather Limitations.** Do not spread bituminous material when weather conditions are unsuitable, when rain is imminent, when the pavement surface is wet, when excessive wind causes problems, or when the humidity is higher than 50%. Do not spread bituminous material when the atmospheric temperature is below 18 °C (65 °F), when the pavement temperature is below 27 °C (80 °F), or when the pavement temperature is more than 60 °C (140 °F). Do not place screenings if there is a forecast of the atmospheric temperature falling below 2 °C (35 °F) within 24 hours of placement.

**408.03.05 Maintaining Traffic.** When traffic is maintained, do not apply the surface treatment to more than half the width of the traveled way at a time, and keep the remaining half width free of obstructions and open for use by public traffic at all times.

Place dust hazard and loose gravel signs with advisory speed plates alternatively spaced at 1.6 km (1 mi) intervals.

Do not place traffic on the newly placed bituminous material and screenings until they have sufficiently set and bonded.

When the newly completed surface treatment is open to public traffic, control traffic by use of flaggers and a pilot car for a minimum of 24 hours or for such time as deemed necessary as follows:

(a) Station a flagger at the beginning of each newly completed section, to stop oncoming traffic preparatory to piloting operations. Keep the flaggers on duty during the entire control period.

(b) Do not operate the pilot car at speeds greater than 40 km/hr (25 mph) on newly constructed surface treatments.

(c) Move traffic control as described above, ahead progressively as the newly completed surface is open to traffic.

**408.03.06 Preparation of Surface.** See Section 202 for removal of pavement markings. Remove such markings as provided for in Section 202 before applying bituminous material.

Remove and dispose of all vegetation that will interfere with the uniform application of bituminous material and screenings onto the existing pavement surface.

Identify and protect drains, manholes, inlets, monuments, and utility covers by applying a sheet of plastic, cut to fit, or use another method as approved or directed prior to surface treatment application. Identify and protect railroad tracks, bridge expansion joints, curbs, gutters, and other facilities from the applications of bituminous material and aggregates. Remove all traces of plastic, residual emulsion, and aggregates from the protected facilities the same working day as the surface treatment application has passed the protected locations.

Place temporary lane line markers according to Section 633 at least 24 hours before applying the screenings.

Immediately before applying the bituminous material, thoroughly clean the surface to be treated of all dirt and loose material by sweeping with power brooms supplemented by hand brooms if necessary. Continue the cleaning process until the surfacing is exposed and all dirt and loose material is removed from the entire width of surfacing.

**408.03.07 Application of Bituminous Material.** Uniformly apply bituminous material by means of a pressure distributor in a continuous spread. The temperature of the bituminous material shall conform to Subsection 406.03.04. Use the quantity of bituminous material per square meter (square yard) as directed. If bituminous material penetrates the surface too rapidly, a preliminary application of 0.45 L/m$^2$ (0.1 gal/yd$^2$) may be required. Use a strip of building paper at least 0.9 m (3 ft) in width and with a length equal to that of the spray bar of the distributor plus 0.3 m (1 ft), at the beginning of each spread. Remove and dispose of the paper in a satisfactory manner.

Move the distributor forward at proper application speed at the time the spray bar is opened. Adjust the distributor speed to coordinate with the chip spreader speed and rolling operations speed to prevent stop-start operations and ensure synchronized forward movement. Do not operate the distributor at speeds greater than 8 km/hr (5 mph) when applying bituminous material. Limit distributor speed so that the distributor pump does not operate at more than 90% of its total capacity. Correct any skipped areas or deficiencies. Carefully make junctions of spreads to assure a smooth riding surface.

Do not apply bituminous material more than 50 m (150 ft) in front of the spreader. Cover immediately with screenings.

Do not spread bituminous material wider than the width covered by the screenings from the spreading device. Do not allow bituminous material to chill, set up, dry, or otherwise impair retention of the screenings.

Park the distributor, when not spreading, so that bituminous materials will not drip on the surface of the traveled way.

The application rate of bituminous material to be applied to the existing pavement surface may vary within the project limits due to differing surface conditions, to obtain the required embedment depth of 50% to 70%, or to achieve acceptable surface treatment application. Make adjustments to the bituminous material application rate as directed.

**408.03.08 Application of Screenings.** Immediately following the application of the bituminous material, spread screenings within 10% of the required rate per square meter (square yard).

Avoid building raised longitudinal joints. Construct the longitudinal joints by applying the screenings the same width as the bituminous material. Prior to the second pass of the distributor, use a power broom to broom back 100 to 150 mm (4 to 6 in.) of the first pass of the surface treatment to remove any chips that failed to get adequate embedment. Maintain a straight and uniform alignment.

Offset longitudinal joints of successive courses of surface treatment 150 mm (6 in.). Place surface treatment so that final longitudinal joints are constructed at an offset of 150 mm (6 in.) from the final traffic lane lines.

Do not spread bituminous material and screenings over a greater distance than can be rolled and finished within one day's operation.

Provide surface damp screenings at the time of application. Excess water on the aggregate surface will not be permitted.

Do not operate the spreader at speeds which cause the screenings to roll over after striking the bituminous covered surface.

On two lane travel ways, apply bituminous material and screenings to half of a given roadway at a time and in such a manner that every other days operation brings the limits of the surface treatment to a near common point.

Cover the emulsified asphalt applied to the road surface with screenings before setting or breaking occurs.

In order to eliminate hauling over the new surface treatment, begin screening operations at a point furthest from the material source and work toward the material source. Stagger aggregate delivery truck wheel paths across the travel lane behind the spreader to aide rolling operations. Aggregate delivery trucks shall travel at speeds less than 40 km/hr (25 mph) on the newly constructed surface treatment. Aggregate delivery truck operators shall make gradual stops, starts, and turns.

After the screenings have been spread, carefully remove any piles, ridges, or uneven distribution with flat bottom shovels, or other approved methods to insure against permanent ridges or bumps in the completed surface. Spread additional screenings by hand in whatever quantities required to prevent picking up by the rollers or traffic.

**408.03.09 Rolling.** Begin rolling immediately behind the screening application to properly embed the screenings in the soft bituminous material. Commence rolling at the outer edge and proceed toward the inner edge on each spread. Continue rolling until the screenings are thoroughly set.

Roller speed shall not exceed 8.0 km/hr (5 mph). Roller stops, starts, and turns shall be made gradually.

Use an approved sequence of rollers and roller patterns.

**408.03.10 Removal of Loose Screenings and Surface Maintenance.** Lightly broom the surface to remove all loose chips approximately 3 hours after the start of the screening application. Do not apply heavy pressure to the broom core which will cause dislodging of chips from the surface. Do not allow traffic on screenings until after the light brooming operations are completed.

Use a minimum of 3 self-propelled power brooms equipped with pressure type distributor spray systems that will ensure uniform application of water for dust control. The brooms shall be capable of removing loose screenings adjacent to barriers (including curbs, gutters, and railings) that prevent screenings from being swept off the pavement. Provide brooms capable of downward pressure adjustment. Do not use gutter or steel-tined brooms.

If operated at night, equip brooms with tail, stop, and directional lights, and an amber strobe light.

Operate brooms at 6 to 9 km/hr (4 to 6 mph).

Apply adequate water during all brooming to control dust.

Remove and dispose of excess screenings which will interfere with drainage.

Complete surface to a uniform appearance and free from ruts, humps, depressions or irregularities due to an uneven distribution of bituminous material or screenings. Repair unacceptable areas. Provide repair crew personnel specifically designated and dedicated to performing the necessary repairs.

After the application of screenings, lightly broom and maintain the surface for a period of 4 days.

Perform the light brooming to remove loose screenings prior to the end of each day's work or as the first order of work on the morning following application of screenings. Perform the initial brooming between sunrise and 10:00 a.m. Broom the entire surface that has had screenings applied to it on the previous day. Completely remove all loose screenings from the paved roadway surface. Perform a second brooming within 48 hours after the initial brooming. Additional brooming shall be required as often as necessary between the first and fourth day after applying screenings to maintain the surface free of loose screenings. At the end of 4 days after applying screenings, remove any excess screenings from all paved areas. Perform sweeping or brooming of the surface treatment in such a manner that the screenings set in the bituminous material will not be displaced. Do not excessively broom the surface.

Maintain the surface for the 4 day period by spreading additional screenings to absorb any free bituminous material, to cover any areas deficient in screenings, and to eliminate surface irregularities. If approved, clean sand may be used in lieu of screenings to cover any excess bituminous material which comes to the surface. Do not use roadside material for this purpose.

**408.03.11 Screenings (In Stockpile).** Clear the stockpile area of all brush, rubbish, and deleterious material. Give notification once the stockpile area has been cleared and not less than 72 hours prior to commencing crushing and screening operations in order that cross sections of the area may be obtained prior to stockpiling operations.

Place the screenings in uniformly shaped stockpiles as directed. Keep stockpiles of different materials separated to prevent intermixing. The exact location of stockpiles will be determined.

## METHOD OF MEASUREMENT

**408.04.01 Measurement.** Bituminous material will be measured by the metric ton (ton).

Screenings will be measured by the metric ton (ton) or cubic meter (cubic yard).

Screenings (In Stockpile) will be measured by the metric ton (ton) or cubic meter (cubic yard).

The mass of any water added to the screenings before weighing will be deducted from the quantity measured for payment.

## BASIS OF PAYMENT

**408.05.01 Payment.** The accepted quantities, measured as provided above, will be paid for at the contract price per unit of measurement for the pay items listed below that are shown in the proposal. Payment will be full compensation for the work prescribed in this Section.

If the results of the Cleanness Value test for screenings, as required in Subsection 705.03.04, is below 81, remove the surface treatment represented by such test. No single Cleanness Value test will represent more than 1800 metric tons (2000 tons).

If requested in writing and approved, surface treatments containing screenings with a Cleanness Value below 81, but not less than 73, may remain in place. Pay to the Department as liquidated damages the following amount for such screenings left in place.

| Cleanness Value | Liquidated Damages Per metric ton (ton) |
|---|---|
| 79 to 77 | $13.20 ($12.00) |
| 75 to 73 | $26.40 ($24.00) |

The Department will deduct these amounts from any monies due, or that may become due, under the Contract.

Flaggers, pilot car, and construction signs will be paid for according to Section 624 and 625.

Payment will be made under:

| Pay Item | Pay Unit |
|---|---|
| Emulsified Asphalt (type) | Metric Ton (Ton) |
| Screenings (size) | Metric Ton (Ton), Cubic Meter (Cubic Yard) |
| Screenings (size) (In Stockpile) | Metric Ton (Ton), Cubic Meter (Cubic Yard) |

# SECTION 409

## PORTLAND CEMENT CONCRETE PAVEMENT

### DESCRIPTION

**409.01.01 General.** This work consists of constructing Portland cement concrete pavement on a prepared surface.

### MATERIALS

**409.02.01 General.** Material shall conform to the following Sections:

| | |
|---|---|
| Portland Cement Concrete | Section 501 |
| Reinforcing Steel | Section 505 |
| Portland Cement | Section 701 |
| Concrete Curing Materials and Admixtures | Section 702 |
| Aggregates for Portland Cement Products | Section 706 |
| Water | Section 722 |

Concrete for Portland cement concrete paving shall be Class PCCP conforming to Section 501 with the modifications and additional requirements specified herein.

Use a three aggregate system consisting of a blend of two Coarse Aggregates from Subsection 706.03.01 and Fine Aggregate conforming to Subsection 706.03.03. Use American Concrete Institute, Manual of Concrete Practice, Guide 302.1R-04, Section 5.4.3 Combined Aggregate Grading to optimize the combined aggregate grading within the grading limits below. Submit the results with the mix design.

For mix design approval and as a project control requirement, the proposed proportions of individual aggregates, combined mathematically, by volume or mass, shall produce a mixture within the grading limits for combined aggregates as follows:

**Grading Limits of Combined Aggregates**

| Sieve Size | Percent Passing by Mass |
|---|---|
| 50 mm (2 in.) | 100 |
| 37.5 mm (1 1/2 in.) | 90-100 |
| 25 mm (1 in.) | 50-86 |
| 19 mm (3/4 in.) | 45-75 |
| 9.5 mm (3/8 in.) | 38-55 |
| 4.75 mm (No. 4) | 30-45 |
| 2.36 mm (No. 8) | 23-38 |
| 1.18 mm (No. 16) | 15-33 |
| 600 µm (No. 30) | 8-22 |
| 300 µm (No. 50) | 4-13 |
| 150 µm (No. 100) | 1-5 |
| 75 µm (No. 200) | 0-3 |

The air range indicated is not required in Clark County.

For mix design approval, testing shall demonstrate that a minimum flexural strength of 4.5 MPa (650 psi) will be achieved at 28 days. An average of 3 beams, when cured and tested according to Test Method No. Nev. T442, shall meet or exceed 4.5 MPa (650 psi) with no individual beam having a strength less than the specified strength.

### CONSTRUCTION

**409.03.01 Equipment**. (a) General. Equipment and tools necessary for handling materials and performing all parts of the work must be approved as to design, capacity, and mechanical condition. Provide this equipment on the site, available for inspection, testing, and approval before paving operations are started. Maintain all equipment, tools, and machinery in a satisfactory working condition.

Provide equipment of such capacity that the paver will operate continuously or at a constant rate of production. If any piece of equipment does not have sufficient capacity to keep pace with the other operations, the Engineer may limit the size of the batch or otherwise limit the rate of production to prevent poor workmanship, overloading of equipment, or frequent delays.

Equipment that will be operating entirely or partially on any existing pavement shall have rubber-tired wheels in contact with the pavement. Hard tracked equipment will not be allowed to run on the pavement regardless of the pavement age or strength.

Provide lightweight concrete saws (early entry saws) specifically designed for sawing fresh concrete without the use of water for constructing weakened plane joints in the concrete pavement.

Provide vibratory equipment to consolidate the concrete. Cores may be taken to verify adequate consolidation of the concrete.

Provide adequate internal vibrating equipment, including power, to enable the Engineer to fabricate concrete cylinders for testing purposes.

(b) Batch Plant and Equipment. Provide a copy of the plant certification as specified in Subsection 106.07 and receive approval prior to performing any work.

For all batches with a volume of 1 $m^3$ (1 $yd^3$) or more, provide batching equipment conforming to one of the following combinations:

1. Separate boxes and separate dial or beam scales for weighing each size of aggregate.
2. Single box and dial or multiple beam type scales for all aggregates.
3. Single box or separate boxes and automatic weighing mechanism for all aggregates.

In order to check the accuracy of batch masses, determine the gross mass and tare mass of batch trucks, truck mixers, and truck agitators, when ordered. Weigh the equipment on approved scales.

Proportion aggregates and bulk cement by mass by means of automatic proportioning devices of approved type conforming to the requirements specified herein.

Weigh bulk cement on scales separate and distinct from the aggregate hoppers. Interlock the discharge mechanism of the bulk cement hopper against opening before the full amount of cement is in the hopper, against closing before the contents of the hopper are entirely discharged and the scales are back in balance, and against opening when the amount of cement in the hopper is either over or under mass by more than 1% of the amount specified.

Interlock the bulk cement batcher and aggregate batcher so that a new batch of cement cannot be started until all weigh hoppers are empty, the scale is at zero, and the discharge gates are closed.

Equip the batch plant with a numerical printout device that will make a continuous, permanent, and accurate record of the masses of cement, gravel, and sand as well as the amount of water and additives used in each batch of concrete and the target weights. Provide the record immediately after each batch is produced.

Design the discharge gate on the cement hopper so as to permit regulating the flow of cement into the aggregate as approved.

Control material discharged from the bins by gates or by mechanical conveyors. Interlock the means of withdrawal from the bins, and of discharge from the weigh hopper, so that not more than one bin can discharge at a time, the order of discharge can be changed, and the weigh box cannot be tripped until the required quantity from each of the bins has been deposited therein. Should a separate weigh hopper be used for each size of aggregate, all may be operated and discharged simultaneously.

When the discharge from the bins is controlled by gates, actuate each gate automatically so that the required mass is discharged into a weigh hopper, after which the gate shall automatically close and lock.

Provide a weighing device which is automatic to the extent that the only manual operation required for proportioning the aggregates and cement for a batch is a single operation of a switch or a starter.

Provide a stable platform with canopy from which the inspector can step onto the bed of the trucks in order to take samples. Locate platform no farther than 75 m (250 ft) from the mixer. Provide platform with a height equal to the height of the truck beds and at least 10.7 m (35 ft) long and 2.4 m (8 ft) wide with a 2.4 m x 2.4 m x 2.4 m (8 ft x 8 ft x 8 ft) lockable insulated shed at one end for cylinder storage. Provide the platform with adequate railing and stairs with handrail down to ground level. Construct the platform of either wood or steel, and conforming to the standards contained in "Safety and Health Regulations for Construction" of the Department of Labor. Temperature

control the shed in order to maintain the concrete test cylinders within the temperature range required by Test Method No. Nev. T428. Supply potable running water to the platform, 110 V electrical power, suitable lights, vibrators, and outlets. Furnish radios or telephones so the inspector on the platform can communicate with the batch plant operator.

(c) Mixers. Furnish mixing equipment conforming to Subsection 501.03.06.

(d) Vibrators. Furnish internal vibrators with rigid or flexible shafts, preferably powered by electrical motors, capable of operating at a frequency of 7,000 vibrations per minute or greater. The outside diameter or the side dimensions of the vibrating element shall be at least 19 mm (0.75 in.) and not greater than 38 mm (1.5 in.). The length of the shaft shall be at least 600 mm (24 in.). Furnish a tachometer or other suitable device for measuring and indicating the actual frequency of vibrations.

Do not rest vibrators on new pavements or side forms. Connect power to the vibrators so that vibration will cease when the forward or backward motion of the machine is stopped.

(e) Forms. Use equipment utilizing stationary side forms or slip-form paving equipment.

If using side forms, use only metal side forms, weighing not less than 26 kg/m (18 lb/ft), without stakes.

Furnish side forms of sufficient rigidity, both in the form and in the interlocking connection with the adjoining forms, so that springing will not occur under the mass of the grading and paving equipment or from the pressure of the pavement when placed.

Furnish straight side form sections, free from warps, bends, indentations, or other defects. Remove defective forms from the work.

Equip slip-form paving equipment with traveling side forms of sufficient dimensions, shape, and strength to support the concrete laterally for a sufficient length of time during placement to produce pavement of the required cross section.

Do not create abrupt changes in longitudinal alignment of the pavement. Do not deviate more than 30 mm (1.2 in.) horizontally from the established alignment.

(f) Vibrators for Testing Purposes. Provide adequate internal vibrating equipment, including power, to enable the Engineer to perform tests. Vibrators shall conform to the requirements as specified above.

(g) Fogging Machine. Provide a fogging machine capable of applying water in the form of a fine mist spray over the entire width of the concrete pavement. Create fine mist by pumping water, or a combination of air and water under high pressure in combination with a suitable atomizing nozzle. Adapt fogging machine for intermittent or continuous use to prevent excessive wetting of the concrete, and make it capable of repeated passes in order to prevent shrinkage cracking of the concrete.

**409.03.02 Preparation of Grade.** Place a bond breaker of white pigmented wax based curing compound on the prepared surface. Apply bond breaker in a single application at a rate of 0.60 ± 0.10 L/m$^2$ (2 gal/150 ft$^2$ ± 25 ft$^2$). Allow adequate time for the bond breaker to cure as per the manufacturer's recommendations before placing concrete. Repair or reapply bond breaker that has been contaminated or otherwise affected and which will not perform the function as intended. Apply a fine spray of water to the bond breaker immediately before concrete placement begins.

**409.03.03 Setting Forms.** Before placing side forms, construct the underlying material to the proper grade. Place side forms with full bearing upon the foundation throughout their length and width of base and place to the required grade and alignment of the edge of the finished pavement. Support forms so that they will not deviate vertically at any time more than 3 mm (0.01 ft) from the grade established.

Provide stake pockets and interlocking devices that will prevent movement of the forms.

Stake side forms firmly by means of steel stakes at each end of the section and at intermediate points not more than 1.5 m (5 ft) apart and design so that stakes may be driven through the base of the form. Lay side form sections with an expansion gap of approximately 3 mm (0.01 ft). Use stakes of sufficient length so that the side forms will be held firmly in place. Provide longer stakes if lateral movement of forms is greater than 6 mm (0.02 ft) while supporting moving equipment.

When a straightedge 3.6 m (12 ft) long is placed on the top of any side form, the top of the side form shall not vary more than 3 mm (0.01 ft) from the lower edge of the straightedge. When a straightedge 3.6 m (12 ft) long is placed against the inside face of any side form, the inside face of the side form shall not vary more than 6 mm (0.02 ft) from the straightedge. Immediately in advance of placing pavement and after all subgrade operations are completed, true and maintain side forms to the required line and grade for a distance sufficient to prevent delay in placing the pavement.

Keep side forms in place until the day after placing the pavement, and in all cases until the edge of the pavement no longer requires the protection of the forms.

Thoroughly clean and oil side forms each time they are used.

**409.03.04 Reinforcement.** Install reinforcing steel if required.

Hold bar reinforcement accurately and firmly in position during the placing and compacting of the concrete without sagging by means of supporting devices to be left in place. Specifically manufacture the supports for this purpose. Design each support to hold a minimum vertical load of 90 kg (200 lb).

**409.03.05 Mixing.** Mix concrete according to Subsections 501.03.06 and 501.03.07, and as specified herein.

Provide and maintain suitable nonresettable batch counter in proper operating order, which will correctly indicate the number of batches proportioned at the batching plant and mixed in the mixers.

Thoroughly mix concrete to a homogeneous appearance, without lumps of sand or cement or other evidence of undispersed cement. Non-homogeneous concrete will be rejected.

Mix concrete not less than 60 seconds or more than 90 seconds. The actual mixing time will be determined. Begin mixing time upon completion of charging of all materials into the mixing drum. Mixing time ends when mix discharge begins. Transfer time in multiple drum mixers is included in mixing time. Remove the contents of an individual mixer drum before a succeeding batch is emptied therein.

Charge the batch into the drum so that a portion of the mixing water enters in advance of the cement and aggregates. Uniformly add all water in the drum by the end of the first 15 seconds of the mixing period. Keep the throat of the drum free of such accumulations as may restrict the free flow of materials into the drum.

**409.03.06 Test Strip.** Prior to performing concrete pavement placement, construct a test strip of at least 50 m (150 ft) in length and to a width that will be common to the majority of production placement. Construct the test strip with the equipment and mix design that will be used throughout the concrete paving operation. Should a change in the equipment or mix design occur at any time during the concrete paving operation, an additional test strip may be required. The test strip shall be constructed under the same conditions that will occur during production. These conditions are to include anticipated working shift and atmospheric and surface temperatures. Suspend concrete pavement placement operations for 10 working days. The test strip will be evaluated to ensure conformance with the plans and specifications.

Remove test strips not conforming to the requirements of the plans and specifications from the roadway and dispose of according to Subsection 107.14. Construct additional test strips until approval is given to begin the production of concrete pavement placement. Test strips conforming to the plans and specifications will be considered as permanent concrete pavement and will be measured for payment as specified in Subsection 409.04.01. Acceptance of the test strip shall not relieve the Contractor of responsibility to complete the remainder of work in accordance with the plans and specifications.

**409.03.07 Placing Concrete.** Do not place concrete when the surface temperature is less than 0 °C (32 °F) or greater than 32 °C (90 °F). Do not place concrete while the atmospheric temperature is below 2 °C (35 °F) unless adequate means are employed to heat the aggregates and water, and satisfactory provisions made for protecting the work. Do not place concrete where ponded water, snow, or other foreign debris is on the surface. If necessary, the surface of the base may be cooled by watering sufficiently in advance of concrete placement.

In the event of rainfall, stop placing concrete before the quantity of rainfall is sufficient to cause a flow or wash the surface or as directed.

After the concrete has been batched and delivered to the project, only one attempt may be made, by adding approved admixtures, to bring the slump and air content into specification. Do not make any adjustments to the mix

if more than 10% of the originally batched concrete has been discharged from the delivery vehicle.

Do not use concrete showing improper proportions of materials, including water. Remove and dispose of any such unsatisfactory concrete.

Equipment that damages the base course will be prohibited from traveling thereon.

Prevent delay in delivery and placing of the concrete. An interval of more than 45 minutes between placing of any 2 consecutive batches or loads will constitute cause for stopping paving operations. If so ordered to shut down, make a contact joint at the location and of the type directed, in the concrete already placed.

Place concrete pavement in 3.6 m (12 ft) traffic lane widths separated by contact joints, or place monolithically 2 or more lanes wide without a contact joint, but with a longitudinal weakened plane joint at each traffic lane line.

Protect freshly placed pavement, previously constructed pavement, and existing pavements from damage by any cause. Repair all damage.

Protect expansion joint material while depositing fresh concrete adjacent thereto.

Adequately barricade concrete work area in all directions to protect the work.

**409.03.08 Spreading, Compacting, and Shaping.** (a) Side Form Construction. Distribute the concrete uniformly with a mechanical spreader.

Vibrate and screed the spread concrete by a machine or machines.

Vibrate the concrete, for the full paving width, by means of surface vibrators with internal vibrators adjacent to each longitudinal edge or by some other method of vibration that produces equivalent results without segregation. Vibrate at a rate of not less than 3,500 vibrations per minute for surface vibrators and 5,000 vibrations per minute for internal vibrators. Operate the amplitude of vibration to be perceptible on the surface of the concrete more than 300 mm (12 in.) from the vibrating element.

Furnish adequate machines to perform the work required at a rate equal to the progress of the mixer. Any delay in excess of 15 minutes in vibrating and screeding will constitute cause for stopping the mixer until the machines performing such work are again in proper position in the paving train.

Perform screeding by making at least 2 complete passes over the entire area of the pavement. Adjust the screed to an elevation slightly above grade so that when properly consolidated and finished, the completed surface of the pavement will be at the established grade, true to the cross section shown on the plans, and free from porous areas. Keep the tops of the forms or the adjacent pavement and the contact surface of the crawler tracks or wheels clean by effective devices attached to the machine. Maintain the travel of the machine true without lift, wobble, or other variation tending to affect precision screeding. During each pass of the machine, maintain a roll of concrete ahead of the front screed for the entire width of pavement being placed and, except when making an expansion joint, do not operate the machine beyond that point where the roll of concrete can be maintained. Use equipment to produce a surface requiring minimum cutting during the floating and final finishing process as specified in Subsection 409.03.11.

Submit a written proposal for approval, detailing the equipment, materials, and procedures to be used for concrete widths less than one traffic lane.

(b) Slip-Form Construction. References at reasonable intervals on both sides of the roadway, for line and grade control of the placing operations will be established. Furnish, place, maintain, remove, and dispose of such supports, wire devices, and materials as may be required to provide continuous line and grade reference controls to the placing machine or paver. Equip the slip-form paver with a control system which will automatically sense and simultaneously control the laying and trimming of the materials to the specified longitudinal and lateral grade, from both sides of the roadway. Automatically actuate the control systems from independent line and grade control references through a system of mechanical sensors or sensor directed devices which will maintain the equipment at the proper transverse slope and at the proper elevation to obtain the required thickness and surface.

Deliver the fresh concrete to the front of the paver by means of a belt feeding device or other device that is capable of loading concrete onto the dowel bar baskets and in front of the paver without causing the misalignment of the dowel bars as the paver passes.

Spread, consolidate, screed, and float-finish the freshly placed concrete with slip-form paving equipment in such a manner that a minimum of finishing with a hand float will be required.

Distribute the concrete uniformly into final position by the slip-form paver without delay.

Effectively consolidate the concrete, for the full paving width, by internal vibration with transverse vibrating units or a series of equally spaced longitudinal vibrating units. If a series of longitudinal vibrating units are used, equally space them at intervals not to exceed 0.75 m (2.5 ft) measured center to center. Vibrate at a rate of not less than 3,500 vibrations per minute for surface vibrators and 5,000 vibrations per minute for internal vibrators. Operate the amplitude of vibration to be perceptible on the surface of the concrete more than 300 mm (12 in.) from the vibrating element.

The term "internal vibration" used above shall mean vibration by means of vibrating units located within the specified thickness of pavement section and a minimum distance ahead of the screed equal to the pavement thickness.

At locations inaccessible to slip-form paving equipment, place concrete pavement according to the requirements for placing concrete in widths less than a traffic lane as specified above for side form construction. At such locations, use stationary side forms conforming to Subsection 409.03.01 (e). Finish locations inaccessible to the slip-form paving equipment by the hand float method and equipment specified in Subsection 409.03.11 (b).

**409.03.09 Joints.** (a) General. Joints in pavement will be designated as longitudinal and transverse contact joints, transverse expansion joints, and longitudinal and transverse weakened plane joints.

Construct transverse joints at the angle to the centerline of the pavement shown on the plans. Construct faces of both transverse and longitudinal joints normal to the surface of the pavement.

Keep sawed joints clean and free of all foreign material after completion of shoulder work and before acceptance of the contract.

Use tie bars for all longitudinal contact joints and longitudinal weakened plane joints. Place straight tie bars mechanically by an approved method. Do not place tie bars closer to adjacent dowel bars than allowed in the Standard Plans. Use tie bars conforming to AASHTO M31 Grade 300 (40) or Grade 420 (60) steel and epoxy coat as specified in Section 505.

Tie bars may be bent at right angles against the form of the first lane constructed and straightened into final position before the concrete of the adjacent lane is placed. If an "S" shaped bend is formed in straightening the bar, do not allow the offset from a straight line to be more than 30 mm (1.2 in.). In lieu of bent tie bars, approved 2 piece connectors may be used.

Dowel bars are required for all transverse weakened plane joints and transverse contact joints as shown on the plans.

Place the dowel bars within 25 mm (1 in.) of the planned transverse and depth location and within 50 mm (2 in.) of the planned longitudinal location. Place the dowel bars parallel to the pavement surface and centerline within a tolerance of 12.5 mm in 450 mm (0.5 in. in 18 in.).

Do not interrupt the forward movement of the finishing beam or screed by the inserting of the dowel bars.

Provide an approved method of marking the locations of the transverse joints.

Dowel bars shall be plain, round, smooth, coated bars, free from burrs or other deformations detrimental to free movement of the bars in the concrete. Provide dowel bars of the size and length shown on the plans and with at least one end sawed. Dowel bars shall be Corrosion Resistant Dowel Bars meeting the requirements of AASHTO M254, Type B, except the core material shall be of steel meeting the requirements of AASHTO M31, Grade 300 (40) or Grade 420 (60), or the equivalent, except that the bend test will not be required. The coating material shall meet the coating material requirements of AASHTO M284. Coat the cut ends of the dowel bars. Uniformly apply an approved bond breaker to the coated bar before insertion in the concrete. Use the type of bond breaker as recommended by the coating manufacturer. Submit certified test results showing compliance with all requirements of AASHTO M254 for approval. In particular, see the Pull-Out Test requirement of AASHTO M254. Perform this test on bars to which the proposed bond breaker has been applied. The test report shall identify the type of bond breaker used.

Place dowel bars by one of the following methods:

1. Automatic Dowel Bar Inserter Method. The automatic dowel bar inserter shall have a successful performance history. Submit documentation regarding performance history of the dowel bar inserter for approval.

   Place and consolidate the pavement to full depth before insertion of the dowel bars. Insert the dowel bars into the concrete ahead of the finishing beam or screed.

2. Wire Basket Method. Use wire basket type supports specifically manufactured for this purpose. Determine the type of dowel supporting baskets as well as the method of anchoring. Dowel bars may be tack welded at alternating ends, to the basket assemblies, to prevent slippage. No portion of the dowel support assembly shall cross the transverse joint.

   Securely anchor and construct dowel bar assemblies to firmly hold all the dowel bars at the specified depth and alignment. Cut and remove all tie wires or shipping support wires prior to concrete placement.

   Do not start paving until the approved assemblies are in place at least 60 m (200 ft) in advance of the paving. Stop paving at any time that approved assemblies are not in place at least 60 m (200 ft) in advance of the concrete placement operation. This requirement may be waived, upon written request and approval, in areas where access is restricted or other construction limitations are encountered.

   Approval of the initial placement of basket assemblies shall not constitute acceptance of the final position of the dowel bars.

   Consolidate the concrete around the dowel bars such that no voids exist. Do not supplement consolidation by the use of hand held vibrators.

Dowel bar location will be verified for acceptance on all dowel bars placed. If there is a dispute with the results of verification, perform coring at the locations of the bars in question.

Cores shall be a nominal 100 mm (4 in.) in diameter and one core shall be taken at each end of the dowel bar. Once measurements are complete, fill all core holes with an approved patching material.

Control the positioning of dowels in a manner such that dowels meet the specified tolerances. If at any time dowels are found to be installed improperly, the paving operations will be suspended and operations shall not begin until it is demonstrated that the problem which caused the improper dowel positioning has been corrected.

Concrete pavement containing improper dowel positioning will be subject to the provisions of Subsection 105.03.

(b) Contact Joints. Contact joints are those made by placing fresh concrete against hardened concrete at planned locations.

Connect concrete on both sides of longitudinal contact joints with tie bars as shown on the plans.

Connect concrete on both sides of transverse contact joints with dowel bars as shown on the plans.

When the plans require the construction of keyways, construct the grooved portion of the keyway as part of the pavement width being placed.

(c) Weakened Plane Joints. Space transverse weakened plane joints 4.5 m (15 ft) on center and perpendicular to centerline. Cut longitudinal weakened plane joints on all lane lines and shoulder lines. Where the combined width of the Portland cement concrete pavement shoulder and adjacent lane is 4.9 m (16 ft) or less, omit the longitudinal joint between the shoulder and the lane.

Saw weakened plane joints by cutting the pavement with a power driven early entry saw designed for sawing fresh concrete without the use of water. Cut joints when sawcutting equipment can be placed on the surface without raveling, tearing, spalling, or causing any other damage to the newly placed concrete pavement. Determine the exact time to saw joints.

Saw transverse weakened plane joints to a width of 3 mm (1/8 in.) and to a depth of 1/4 of the planned pavement thickness. Saw longitudinal weakened plane joints to a width of 3 mm (1/8 in.) and to a depth of 1/3 of the planned pavement thickness.

After the joint is sawed, clean the saw cut and adjacent concrete surface with a dry vacuum.

Immediately revise any procedure used to saw joints which results in uncontrolled random cracking.

Repair portions of curing seal which are disturbed by sawing operations by spraying the areas with additional curing seal.

Keep a standby power saw on the project at all times when concrete paving operations are under way.

(d) Repair of Spalls, Raveling, and Tearing. Repair spalls, raveling, and tearing at joints before opening the pavement to public traffic.

Submit repair products and procedures for approval.

Repair sawed joints with excessive raveling or tearing. Prepare by removing all weak fractured concrete and cleaning surfaces to receive the patch. Following cleaning of the excavated area and before placement of the concrete patch, apply a prime coat of epoxy conforming to AASHTO M235 (ASTM C881), Type V, to the entire surface to be patched. Immediately apply a patch material conforming to Subsection 502.03.15 following the application of the prime coat. Use an insert, or other means, to prevent bonding both sides of planned joints together.

**409.03.10 Pavement Cracks.** Pavement cracks shall be classified as either plastic shrinkage cracks or random cracks based on the definitions herein.

Plastic shrinkage cracks are generally tight-hairline cracks less than 0.80 mm (1/32 in.) which do not usually penetrate the depth of the slab, and are not structural in nature. They may appear either as irregular “map cracking” or as short irregular cracks roughly parallel to each other. The crack length is generally 50 to 600 mm (2 to 24 in.) and cracks are usually spaced from 50 to 600 mm (2 to 24 in.) apart. They are normally caused by rapid evaporation of water from the surface. They occur soon after the concrete has been placed.

Repair plastic shrinkage cracks unless the cracking exceeds 50% of the slab area, in which case the slab will be considered unacceptable and shall be removed and replaced. Repair plastic shrinkage cracks with crack sealant according to Section 646.

Random cracks are normally located approximately parallel to a sawed joint and may extend the full width or length of the slab and usually penetrate the full depth of the slab. Slabs containing random cracks are unacceptable and shall be removed and replaced.

Remove and replace slabs as directed.

**409.03.11 Finishing.** (a) General. Provide adequate lighting facilities if required for finishing operations.

At the start of each day's work, mark the edge of the new pavement, nearest the outside shoulder, at 15 m (50 ft) from the beginning joint, with an approved stamp. The stamp shall contain the Contractor's name, the month, day, and year the section is placed, and the Engineer's station at the beginning joint. Make the stamp approximately 300 mm x 600 mm (12 in. x 24 in.) in size.

In case fine cracks or hair checks appear in newly placed concrete before it is thoroughly set, apply water in the form of a fine fog mist above the concrete surface until the finishing operations are completed and the curing is applied.

Apply the fog mist to the area between the finishing machine and the tining machine. If the combination of fogging and curing compound application are not or will not be effective in preventing plastic shrinkage cracking, stop paving operations until environmental conditions improve substantially or until other preventative measures are approved in writing.

(b) Oscillating Screed. Provide a free floating oscillating screed device attached to the slipform paver, behind the conforming pan, which is capable of performing final finishing on the concrete surface.

The machine shall have a lightweight aluminum float 300 mm (12 in.) wide and a minimum of 3.6 m (12 ft) long, which oscillates fore and aft in the direction of traffic. Provide a float with the ability to traverse the entire concrete slab from edge to edge.

Connect the float in such a way that it is driven (oscillated), yet it is free floating on the surface of the concrete.

Adjust and set the movements of the float according to concrete surface conditions and forward speed of the paver.

Hand finishing will only be allowed when mechanical finishing equipment breaks down (only for that concrete already deposited on the grade), for narrow or irregular areas, or where use of mechanical equipment would be impractical. Insure that floats are in good working condition. Discontinue use of equipment that leaves ridges, indentations, or other objectionable marks in the surface. Do not add water or chemicals to the pavement surface to aid in finishing. Operate floats to smooth and fill in the open textured surface areas. Keep hand finishing to a minimum. Do not overwork the concrete.

(c) Final Finish. After the preliminary finishing has been completed, round the edges of an initial pavement lane to a 13 mm (1/2 in.) radius. Round transverse contact joints, expansion joints, and joints adjacent to an existing pavement to a 6 mm (1/4 in.) radius.

In advance of the curing operations, or as directed, texture the pavement with a drag strip of burlap or other device which will produce scoring parallel to the centerline. The burlap drag shall consist of one or more pieces of burlap fastened to a cross member riding on the subgrade or side forms by means of wheels or skids to form a continuous strip of burlap the full width of the pavement. Keep drags clean and free from encrusted mortar. Discard drags that cannot be cleaned and substitute new drags.

(d) Surface Tining. In advance of curing operations, use a mechanical steel tine device to form grooves parallel to the centerline. Do not perform tining too early, where by the grooves may close up. Make tines of rectangular cross section and of sufficient thickness and resilience to result in grooves spaced 19 mm (3/4 in.) on center, 2 mm to 3 mm (3/32 in. to 1/8 in.) wide and 3 mm to 5 mm (1/8 in. to 3/16 in.) deep in the finished concrete pavement.

Operate the tine machine at a speed that keeps up with the paving machine.

Tine the pavement within 75 mm (3 in.), but no closer than 50 mm (2 in.), of pavement edges.

Tine the pavement within 75 mm (3 in.), but no closer than 50 mm (2 in.), of the centerline of longitudinal weakened plane joints. Omit tining at this location for a total width of 100 mm (4 in.) to 150 mm (6 in.).

Maintain the tining device clean and free of encrusted mortar and debris to ensure uniform groove dimensions.

Do not tine pavement which has set, whereas the operation is lifting aggregate out of, or tearing, or causing excessive roughness to the pavement surface. In such case, groove the pavement as directed.

Grind and groove pavement surfaces that do not meet tining requirements. Perform grinding and grooving to meet the tining requirements as directed.

(e) Grind Rumble Strips. Mill or grind the rumble strips to the dimensions shown on the plans. Use a milling or grinding machine that produces a reasonably smooth cut surface with 2 mm (1/16 in.) maximum differentials between peaks and valleys.

The alignment of the edge of the ground pattern will be randomly checked. Locate the rumble strips as shown on the plans. Re-cut rumble strips which are misaligned.

Some of the shoulders designated for receiving the rumble strips may have widths of approximately 1.2 m (4 ft) from the shoulder stripe to a vertical obstruction of concrete barrier rail or guardrail. Use milling or grinding machines capable of constructing rumble strips at these locations.

Demonstrate on an initial 150 m (500 ft) test section that the equipment and methods will provide the desired ground rumble strip and surface inside each depression without cracking or spalling the remaining concrete pavement. If the desired results are not being achieved, provide new equipment, new methods, or make necessary adjustments to obtain the desired results. If the initial 150 m (500 ft) test section is unacceptable, repair the surface as directed, make necessary adjustments, and retest.

Use a power broom or sweeper/vacuum to remove waste material resulting from the operation each day. Recover and dispose of waste material according to Subsection 107.14.

Protect adjacent permanent striping from damage. Replace permanent striping damaged by the milling or brooming operations.

**409.03.12 Riding Tolerances.** Produce finished pavement surfacing which conforms to the surface tolerance requirements specified herein.

(a) Straightedge Measurement. The Engineer will perform this measurement. When a straightedge 3.6 m (12 ft) long is laid on the finished surface and parallel with the centerline of the highway, the surface shall not vary more than 3 mm (0.01 ft) from the lower edge of the straightedge. When a straightedge 3.6 m (12 ft) long is laid on the finished surface and at right angles with the centerline and extending from edge to edge of traffic lane, the surface shall not vary more than 3 mm (0.01 ft) from the lower edge of the straightedge. Use abrasive means to remove any points that are high in excess of the straightedge tolerances.

(b) Profilograph Measurement. Furnish and operate a profilograph, as specified in Subsection 402.03.03, at the time and date ordered.

Measure two profiles in each lane at 1 m (3 ft) from and parallel to the traffic lane lines.

Measure profiles for the entire length of each traffic lane. The average of the two profiles per lane will be used to calculate the profile index.

Pavement within 10 m (30 ft) of a bridge deck or approach slab shall meet the profile requirements set forth in Subsection 502.03.16.

Complete initial runs of the profilograph before opening the new pavement to public traffic whenever practical. Submit the profile graphs immediately thereafter for evaluation. A profile index will be calculated for each 0.1 km (0.1 mi) of traffic lane measured according to Test Method No. Nev. T446. Only flagging costs for traffic control required for the initial running of the profilograph will be paid for according to Section 624.

The finished surface shall have a profile index of 80 mm/km (5 in./mi) or less, and not more than 8 mm/0.1 km (0.5 in./0.1 mi), as measured and calculated according to Test Method No. Nev. T446. Should the profile index exceed the allowable indexes, discontinue the paving operations until other means and equipment are proposed for trial and are approved.

Grind areas exceeding the profile index requirements and areas representing high points on the profiles having deviations in excess of 7.5 mm (0.3 in.) as measured according to Test Method No. Nev. T446. Re-measure ground areas for conformance with the profile index and for high points in excess of 7.5 mm (0.3 in.).

Perform additional grinding as necessary to extend the ground area laterally to the nearest lane line or edge of pavement and longitudinally to lines normal to the pavement centerline.

Use grinding machines that are power driven, self-propelled and specifically designed to remove, profile, smooth, and texture concrete pavement. The grinding machine shall have a wheel base of not less than 3.6 m (12 ft.), equipped with a rotating powered mandrel drum with diamond grinding blades of the appropriate bond hardness and a cutting head of not less than 0.9 m (3 ft.) wide. The grinding machine shall provide a surface with a parallel corduroy-type texture consisting of grooves between 2.3 mm (0.10 in.) and 3.3 mm (0.13 in.) wide. The land area shall be 2.0 mm (0.08 in.) wide and 1.5 mm (0.06 in.) higher than the bottoms of the grooves. There shall be between 170 and 190 grooves per meter (52 and 62 grooves per foot). Equip the grinding machine with an effective means of controlling dust and other particulate matter.

Do not cause strain or damage to the underlying surface of the pavement with the grinding machine. Do not use grinding and texturing equipment that causes ravels, aggregate fractures, spalls, or disturbance of joints.

Perform grinding in a longitudinal direction. Satisfactorily grind to produce a uniform textured surface over the surface areas designated for grinding.

Re-groove ground areas as directed to meet the tining requirements of Subsection 409.03.11 (d).

Pick up water and materials produced from grinding and grooving operations and dispose of according to Subsection 107.14.

**409.03.13 Curing.** (a) General. Cure Portland cement concrete pavement by either method specified in this Subsection. In case of low temperatures, increase the curing period according to the provisions of Subsection 501.03.09 (b).

(b) Curing Compound Method. Do not apply the curing compound until all patching and surface finishing, except grinding, has been completed. When directed during periods of hot weather, continue fogging of the concrete with water after curing compound is applied until it is no longer required. Such fogging after the application of the curing compound will be paid for as extra work as provided in Subsection 104.03.

Cure Portland cement concrete pavement with a white pigmented curing compound applied in 2 approximately equal applications. Apply the second application in the opposite longitudinal direction as the first and within 30 minutes after the first application. Uniformly spray surfaces of the concrete pavement which are exposed to the air so as to obtain total coverage of the concrete surfaces. The rate of each application of curing compound at any point shall be 0.30 ± 0.10 L/m$^2$ (1 gal/150 ft$^2$ ± 50 ft$^2$) and the average rate of each application shall be 0.30 ± 0.05 L/m$^2$ (1 gal/150 ft$^2$ ± 25 ft$^2$). Equip power operated spraying equipment for application of curing compound with an operational pressure gage and means of controlling the pressure.

Apply the compound immediately after the moisture sheen begins to disappear from the surface, but before any drying shrinkage or craze cracks begin to appear. In the event of any delay in the application of curing compound, continuously fog with an atomizing nozzle as specified in Subsection 501.03.08, and continue until the application of the compound. Immediately repair any damaged portions of the compound film with additional compound before the expiration of 72 hours after the concrete is placed.

After the completion of the curing period, remove the wax-based curing compound from the pavement surface by sand blasting in those areas intended to receive permanent pavement marking.

(c) Waterproof Membrane Method. Cure by use of waterproof membrane material as specified in Subsection 501.03.08 (b).

**409.03.14 Protection of Pavement.** Protect concrete from freezing or frost for a period of 5 days after placing. Do not allow the temperature of the surface of the concrete to drop below 4 °C (40 °F) for this period of 5 days.

Unless directed, do not permit traffic or equipment on the pavement before a period of 10 days after the concrete has been placed, nor before the concrete has developed a modulus of rupture of at least 3.8 MPa (550 psi), as determined by Test Method No. Nev. T442.

Motor graders used to shape the shoulder material adjacent to the new pavement may be permitted to ride upon one edge of the previously placed concrete at the end of 72 hours, provided that no damage is done on the pavement edge by reason of such operation. Repair damage to the pavement resulting from such operations.

Request in writing to place the tracks of the paving equipment on the pavement after a period of 3 days after the concrete was placed, and the concrete has developed a modulus of rupture of at least 3.4 MPa (490 psi). Do not locate any part of the track closer than 300 mm (12 in.) from the edge of pavement. Do not exert more than 138 kPa (20 psi) pressure on the pavement by the paver track. In case of visible cracking or other damage to the pavement, immediately discontinue operation of the paving equipment on the pavement. Repair damage to the pavement resulting from such operations.

Replace concrete which has been damaged and in the opinion of the Engineer cannot be repaired satisfactorily.

## METHOD OF MEASUREMENT

**409.04.01 Measurement.** Concrete pavement will be measured by the square meter (square yard).

Saw transverse and longitudinal weakened plane joints will be measured by the linear meter (linear foot).

Portland cement concrete pavement curing compound for the bond breaker and for curing the pavement surface will be measured by the liter (gallon).

Grind rumble strips will be measured by the kilometer (mile) longitudinally along each ground shoulder.

**409.04.02 Pavement Thickness.** Construct concrete pavement according to the thickness requirements of the plans and specifications. Do not construe the tolerances allowed for subgrade construction and other specification provisions which may affect thickness to modify such thickness requirements.

The thickness of the pavement will be determined according to ASTM C174.

The primary unit of pavement will be the area of pavement placed in each day's paving operations. Within each primary unit of pavement, there may be an area or areas which have been determined to be a secondary unit or units of pavement, as provided in Subsection 409.04.02 (b). In such case, the primary unit area will be reduced by the secondary unit area included therein.

After requirements of Subsection 409.03.14 have been met, thickness measurements will be made in each primary unit of pavement at the rate of not less than one measurement for each 300 m (1,000 ft), or fraction thereof, of pavement placed in each traffic lane, auxiliary lane or shoulder. The exact location and number of thickness measurements within each primary unit, both longitudinally and transversely, will be determined. Thickness measurements will be made at approximately uniform intervals throughout each primary unit of pavement.

If required, secondary thickness measurements will be made as provided in Subsection 409.04.02 (b).

Pavement thickness variation, if any, from the thickness requirements of the plans and specifications will be determined. Such variation will be determined as either excess or deficient thickness.

(a) Thickness Deficiency of Not More Than 15 mm (0.6 in.). If the thickness measurements in a primary unit are deficient in thickness by not more than 15 mm (0.6 in.), thickness variations in such unit will be averaged, algebraically, to determine the average thickness deficiency, if any, in said primary unit. For the purpose of determining the average thickness deficiency, an excess thickness variation of more than 5 mm (0.2 in.) greater than the thickness specified will be considered to be 5 mm (0.2 in.) greater than the specified thickness.

For each primary unit of pavement which is deficient in average thickness, pay to the Department as liquidated damages, or at the Department's option, have deducted from any money due, or to become due from the Department, an amount set forth in the following schedule:

| Average Thickness Deficiency mm (in.) | Liquidated Damages % of bid price |
|---|---|
| 0.0-5.0 (0.0-0.20) | 0 |
| 5.1-7.5 (0.21-0.30) | 10 |
| 7.6-10.0 (0.31-0.40) | 15 |
| 10.1-12.5 (0.41-0.50) | 25 |
| 12.6-15.0 (0.51-0.60) | 30 |

(b) Thickness Deficiency of More Than 15 mm (0.6 in.). If the thickness measurement made in a primary unit is deficient in thickness by more than 15 mm (0.6 in.), secondary thickness measurements and dimensions of the secondary unit area where the apparent thickness deficiency is more than 15 mm (0.6 in.) will be determined. The determination of the limits of said secondary unit area will be made by making secondary thickness measurements in each panel of pavement adjacent to the panel in which the original measurement in the primary unit was made. This procedure will continue, regardless of unit boundaries, until such secondary unit area is bounded by panels in which the secondary measurement is deficient in thickness by 15 mm (0.6 in.) or less.

Panels are the areas bounded by longitudinal and transverse joints and pavement edges.

After eliminating the secondary unit area, or areas, and the thickness measurements therein from consideration, the average thickness deficiency, if any, of the remainder of primary unit areas will be determined as provided in Subsection 409.04.02 (a). Secondary thickness measurements made outside of a secondary unit area may be used to determine average thickness deficiency, if any, in the remaining primary unit area in which they are taken.

Each panel in which secondary thickness measurements are made will be deemed to be of the thickness shown by such measurement.

After determining the limits of the secondary unit area, determination will be made of which panels, within such area, if any, will be required to be removed and replaced according to procedure 1, below, and the panels, if any, which will remain in place according to procedure 2, below.

1. Remove and replace the concrete pavement in such panels with concrete pavement meeting the thickness and all other requirements of the contract documents. If the area to be removed is not bounded by longitudinal or transverse joints, saw and seal weakened plane joints at the designated locations. Lower subgrade as necessary to meet the full thickness requirements.

2. Leave such panels of pavement in place without payment.

The cost of secondary thickness measurements made by the provisions in this Subsection, including filling of any necessary holes with concrete, will be deducted from any money due, or that may become due, under the contract.

No additional compensation or extension of time will be granted due to any of the provisions in this Subsection.

No additional compensation will be allowed for any pavement constructed in excess of the thickness requirements of the contract documents.

Additional thickness measurements may be requested in secondary unit areas if the numbers are insufficient to fairly indicate the actual thickness of pavement placed. Such additional measurements will be used in determining the average thickness variation. The location of all such additional thickness measurements will be as determined. The cost of all such additional measurements made, including filling of any necessary holes with concrete, will be deducted from any money due, or that may become due, under the contract.

**409.04.03 Compressive Strength.** If concrete placed is shown by test to be below the specified 28 day compressive strength, a determination will be made as to whether the concrete shall be removed and replaced or allowed to remain in place. If after review, the concrete is allowed to remain in place, liquidated damages will be determined according to Subsection 502.04.01.

Price adjustments for strength and thickness will be determined separately.

BASIS OF PAYMENT

**409.05.01 Payment.** The accepted quantities, measured and adjusted as provided above, will be paid for at the contract price per unit of measurement for the pay items listed below that are shown in the proposal. Payment will be full compensation for the work prescribed in this Section.

Reinforcement, except tie bars and dowel bars, will be paid for as provided in Section 505.

Payment will be made under:

| Pay Item | Pay Unit |
|---|---|
| Portland Cement Concrete Pavement (thickness) | Square Meter (Square Yard) |
| Saw Transverse Weakened Plane Joints | Linear Meter (Linear Foot) |
| Saw Longitudinal Weakened Plane Joints | Linear Meter (Linear Foot) |
| PCCP Curing Compound, Wax Base | Liter (Gallon) |
| Grind Rumble Strips | Kilometer (Mile) |

# SECTION 410

## CONCRETE PAVEMENT RESURFACING

### DESCRIPTION

**410.01.01 General.** This work consists of rubblizing and compacting existing Portland cement concrete pavement for full width and full depth. This work also consists of cracking and seating existing Portland cement concrete pavement for full width and full depth.

### MATERIALS

**410.02.01 General.** Material shall conform to the following Sections and Subsection:

| | |
|---|---|
| Bituminous Materials | Section 703 |
| Base Aggregates | Section 704 |
| Aggregates for Bituminous Courses | Section 705 |
| Commercial Mineral Filler | Subsection 705.03.03 |

### CONSTRUCTION

**410.03.01 Equipment.** (a) Rubblizing Equipment. Use equipment that is capable of rubblizing the existing concrete pavement into particles conforming to the following sieve requirements:

| Sieve Size | Percent Passing by Mass |
|---|---|
| 225 mm (9 in.) | 100 |
| 150 mm (6 in.) | 85-100 |

Equip the rubblizing unit with a water system to suppress dust generated by the rubblizing operation.

(b) Crack and Seating Equipment. Provide an impact hammer of the guillotine type capable of impacting the pavement with a variable force which can be controlled in force and point of impact in order to produce continuous full depth cracking while maintaining aggregate interlock between pieces. Do not use equipment that will cause extensive surface spalling along the crack, that will punch holes in the pavement, or cause shattering of the pavement or base. Spalling over 25 mm (1 in.) in depth will be considered extensive surface spalling. Unguided free falling weights such as “headache” or “wrecking” balls will not be permitted.

**410.03.02 Rubblizing.** Before beginning the rubblizing operations, the Engineer will designate a 30 m (100 ft) long test strip location full width of one lane and adjacent shoulder. Rubblize the concrete pavement in the test strip until the material conforms to the specified size requirements for the full depth of the pavement. Excavate a section of the test strip to assure that full depth rubblizing is being achieved. Excavate full depth approximately 1 m x 4 m (3 ft x 13 ft) in size. Use the equipment and operation approved in the test strip for the remainder of the work.

During rubblizing operations, excavate one additional 1 m x 4 m (3 ft x 13 ft) section per day of the rubblizing operation, and any locations so designated, to assure that full depth rubblizing is being achieved. Repeat this excavation procedure whenever the equipment, rubblizing pattern, or breaking force is changed. Backfill excavated areas with Type 1 Class B aggregate base in accordance with Section 302 at own expense.

Provide a positive means of protecting passing traffic from flying debris during the rubblizing operations.

Restrict the rubblizing equipment to within 600 mm (24 in.) of the existing joint filler next to approach slabs. Provide equipment suitable for rubblizing these small restricted areas adjacent to the approach slabs.

Remove all visible joint material after rubblizing operations.

Compact the rubblized pavement prior to placing the leveling course using vibratory steel wheel and pneumatic tired rollers in the following sequence:

1. One complete coverage with a vibratory roller.
2. Two complete coverages with a pneumatic tired roller.
3. Two complete coverages with a vibratory roller; the last coverage just prior to placing the prime coat and bituminous leveling course.

A complete coverage is defined as a roller pass forward and back within a given area.

Use a vibratory steel wheel roller weighing not less than 9.1 metric tons (10 tons). Operate the vibratory rollers in the maximum vibration mode.

Use pneumatic tired rollers weighing a minimum of 27.2 metric tons (30 tons) consisting of not less than 7 wheels equipped with pneumatic tires of equal size and diameter mounted on 2 axles attached to a rigid frame. Equip pneumatic tired rollers with a loading platform or body suitable for ballast loading so that the total weight of the roller can be equally distributed to all wheels. The minimum width between the outer edge of the outside tires on a given axle shall be 1.5 m (5 ft). Provide tires with satisfactory treads. The tires on the rear axle shall be so spaced that the entire gap between adjacent tires on the front axle will be covered by 1 tread of the following tires. The tires shall be uniformly inflated so that the air pressure in the seven tires will not vary more than 35 kPa (5 psi). Inflation pressure shall be a minimum of 1,034 kPa (150 psi). Do not operate rollers at a speed in excess of 1.8 m/s (6 ft/s).

**410.03.03 Crack and Seating.** (a) General. Accomplish cracking of the existing concrete pavement one lane at a time. A lane is considered the width of a concrete slab. The number of passes required to achieve full width cracking on any lane will be determined by test sections.

Remove all existing asphalt overlays before the cracking and seating operation as specified in Subsection 108.04.

Remove joint filler which becomes debonded during the cracking and seating operation and is left loose and exposed on the surface.

Exercise care during the cracking and seating operation to prevent damage to underground utilities and drainage facilities.

(b) Construction Requirements. Before cracking and seating operations begin, the Engineer will designate a 30 m (100 ft) long test section full width of one lane and adjacent shoulder. Immediately prior to cracking the test section slabs, apply water to the surface of the slabs in sufficient quantity that the existing cracking can readily be determined. Crack the pavement in the test section to establish the impact energy and the number of transverse passes necessary to crack full width and full depth. Achieve cracking without causing longitudinal cracks under the wheel path. To verify that the procedure is producing full depth and full panel width cracked pavement as specified, take at least 4 cores, 100 mm (4 in.) or more in diameter, in the cracked pavement test section. The exact location where cores are to be taken will be determined. Fill core holes as directed. The established impact energy and the striking pattern required to crack full width and full depth shall be used for the remainder of the contract. If the cracked concrete pavement does not conform to the requirements of this Subsection, or the equipment, impact energy, or cracking pattern is changed, crack additional test sections until the equipment and procedure produce cracked pavement as required.

During cracking operations, core the cracked pavement at locations designated at intervals of not less than 1 core per lane kilometer (2 cores per lane mile) for each machine. Consider a 3 m (10 ft) shoulder as a lane. Immediately prior to cracking the concrete pavement, in areas where cores are to be taken, apply water to the surface in sufficient quantity that existing cracking can readily be determined. In the event the cores indicate that cracking is unsatisfactory or if the equipment or procedures are changed, an additional test section will be selected and marked. Crack the additional test section until the equipment and procedure produce cracked pavement as required.

(c) Cracking. Crack existing concrete pavement perpendicular to the centerline to produce individual pavement elements approximately 450 to 500 mm (18 to 20 in.) in size per side without dislodging the cracked pieces or causing surface spalling. Do not allow the pavement cracking tool to impact the pavement within 300 mm (12 in.) of another break line or the edge of pavement.

Crack transition areas before the milling/grinding operation begins.

Prior to opening the cracked pavement to traffic, sweep the pavement of all loose debris, and repair joints, cracks and spalls which are greater than 18 mm (0.7 in.) in width and greater than 50 mm (2 in.) in depth by patching with premixed bituminous paving material according to Sections 401 and 404. Joints, cracks, and spalls less than 50 mm (2 in.) may be patched with premixed bituminous paving material. After patching, sweep the pavement again and remove all loose debris prior to opening to traffic.

Maintain the surface and place premixed bituminous paving material as directed.

Crack and seat the existing surface full width before overlaying. Do not crack adjacent to paved lanes.

(d) Seating. Seat the cracked concrete by making not less than 3 complete coverages over the cracked concrete with a pneumatic tired roller. A complete coverage is defined as a roller pass forward and back within a given area. Use a pneumatic tired roller weighing a minimum of 27.2 metric tons (30 tons) and consisting of not less than 7 wheels equipped with pneumatic tires of equal size and diameter mounted on 2 axles attached to a rigid frame. Equip the pneumatic tired roller with a loading platform or body suitable for ballast loading so that the total weight of the roller can be equally distributed to all wheels. The minimum width between the outer edge of the outside tires on a given axle shall be 1.5 m (5 ft). Provide tires with satisfactory treads. Space the tires on the rear axle so that the entire gap between adjacent tires on the front axle will be covered by 1 tread of the following tires. Uniformly inflate the tires so that the air pressure in the 7 tires will not vary more than 35 kPa (5 psi). Use a minimum inflation pressure of 1,034 kPa (150 psi). Operate the roller at a speed not to exceed 1.8 m/s (6 ft/s). After all segments have been seated, clean loose debris from all joints and cracks by suitable compressed air equipment.

(e) Resurfacing. Place plantmix leveling course within 24 hours of completing the seating operation. Do not allow traffic on the cracked and seated pavement, except for ramp access, before the plantmix leveling course and at least one lift of the plantmix bituminous surface is in place.

Pave full depth through the plantmix bituminous surface within the same construction season the concrete surface is cracked and seated.

Do not place plantmix paving joints over longitudinal joints in the concrete pavement.

## METHOD OF MEASUREMENT

**410.04.01 Measurement.** Rubblize concrete pavement will be measured by the square meter (square yard).

Crack and seat concrete pavement will be measured by the square meter (square yard).

Premixed bituminous paving material will be measured according to Section 404.

## BASIS OF PAYMENT

**410.05.01 Payment.** The accepted quantities, measured as provided above, will be paid for at the contract price per unit of measurement for the pay items listed below that are shown in the proposal. Payment will be full compensation for the work prescribed in this Section.

Payment will be made under:

| Pay Item | Pay Unit |
|---|---|
| Rubblize Concrete Pavement | Square Meter (Square Yard) |
| Crack and Seat Concrete Pavement | Square Meter (Square Yard) |

# SECTION 418

## MICRO-SURFACING

DESCRIPTION

**418.01.01 General.** This work consists of placing a mixture of aggregate, mineral filler, bituminous material, set-control additives, and water.

MATERIALS

**418.02.01 General.** The bituminous material shall be Micro-Surfacing Emulsion conforming to Section 703 for the type specified. Submit a 3.75 L (1 gal) sample of emulsified bituminous material for approval at least 14 days before use.

Aggregate shall conform to Subsection 705.03.06 for the type specified. Produce, stockpile, sample, and test each specified aggregate size according to Section 106.

Mineral filler, as required by the mix design, shall conform to Subsection 705.03.03.

Use a set-control additive as required by the mix design.

Water shall conform to Section 722 and shall be compatible with the mixture.

Store materials in an area capable of preventing water saturation and contamination of stockpiled aggregates.

Empty on-site emulsion storage tanks and clean of all residual asphalt prior to delivery of the first load of approved emulsion.

**418.02.02 Mix Design.** Before commencing micro-surfacing operation, submit a signed original of the mix design for the micro-surfacing material. A separate signed original mix design for each aggregate and emulsion combination will be required. Have the design performed by a qualified laboratory approved by the International Slurry Seal Association (ISSA). Perform the design using materials that are to be used on the project. In the mix design, show the results of tests performed on the individual materials, comparing their values to the specification. Include the test result from the aggregates, emulsion, and micro-surfacing mixture. In the mix design, report the quantitative effects of moisture content on the unit weight of the aggregate (bulking effect). In the lab report, clearly show the proportions of aggregate, mineral filler (minimum and maximum), water (minimum and maximum), additives (usage) and asphalt based on dry aggregate weight. The mix design shall further show recommended changes in cement, water, and additive proportions for high temperature weather conditions by reporting proportions of materials required for 60 seconds of mix time.

The micro-surfacing mixture shall conform to the following:

| TEST | TEST METHOD | REQUIREMENT |
|---|---|---|
| Residual Asphalt, % of dry weight of aggregate | — | 5.5 - 9.5 |
| Mineral Filler, % of dry weight of aggregate | — | 0.0 - 3.0 |
| Wet Cohesion, 30 minute set | ISSA TB139 | 12 kg/cm Minimum |
| Wet Cohesion, 60 minute set | ISSA TB139 | 20 kg/cm Minimum |
| Excess Asphalt by LWT and Sand Adhesion | ISSA TB109 | 50 g/ft$^2$ Maximum |
| Wet Stripping, % coating | ISSA TB114 | 90 Minimum |
| Wet Track Abrasion, 1 hour soak, loss | ISSA TB100 | 50 g/ft$^2$ Maximum |
| Wet Track Abrasion, 6 day soak, loss | ISSA TB100 | 75 g/ft$^2$ Maximum |
| Lateral Displacement | ISSA TB147 | 5% Maximum |
| Specific Gravity after 1000 cycles @ 125 lb | ISSA TB147 | 2.10 Maximum |
| Classification Compatibility | ISSA TB144 | (AAA, BAA) 11 grade points Minimum |
| Mix Time @ 25 °C (77 °F) | ISSA TB113 | Controllable to 120 seconds Minimum |

Mineral filler will be considered as part of the dry aggregate for the mixture.

Furnish aggregates conforming to the mix design, within the following range of tolerances:

| | |
|---|---|
| Aggregate passing the 4.75 mm (No. 4) and larger sieves | ± 5% |
| Aggregate passing the 2.36 mm to 150 µm (No. 8 to No. 100) sieves | ± 4% |
| Aggregate passing the 75 µm (No. 200) sieve | ± 2% |

If it is established that a satisfactory micro-surfacing mixture meeting the requirements specified herein cannot be produced from the materials furnished, the materials will be rejected. Submit new materials and a new mix design.

Once the materials and mix design are approved, substitution of materials will require a new mix design.

CONSTRUCTION

**418.03.01 Equipment.** Mix and apply the micro-surfacing mixture with a machine designed and manufactured to lay the mixture. Use a continuous run machine capable of loading materials while continuing to lay micro-surfacing, thereby minimizing construction joints. The continuous run machine shall be equipped to allow the operator to have full control of the forward and reverse speeds during applications of the mixture and be equipped with opposite side driver station to assist with alignment. The self loading device, opposite driver station, and forward and reverse speed controls shall be original manufacturer design. The machine shall be equipped with a continuous flow mixing unit, automatically sequenced and capable of delivering accurately predetermined proportions of aggregate, water, and asphalt emulsion to a revolving multi-blade, double shafted, spiraled mixer tank. Provide a machine capable of mixing materials at pre-set proportions regardless of the speed of machine and without changing machine settings. Equip the mixing unit with a metering system to accurately meter all liquids by volume by the use of flow meters reading liters (gallons) per minute. The flow of the liquids shall be consistent and precise, and fed into the pugmill in the proportions outlined in the mix design. Equip the mixing machine with an approved fines feeder that provides an accurate metering device or method of introducing a predetermined proportion of mineral filler into the mixer as the aggregate is fed in. Provide a mixing unit capable of thoroughly blending all ingredients together without violent action. The machine shall also be capable of discharging the thoroughly mixed product on a continuous basis. Equip the machine with a hydraulically controlled steel pugmill gate or similar positive discharge device. Control discharge from the pugmill by a chute or other suitable mechanical device. Equip the machine with a temperature indicating device installed in the emulsion tank at the emulsion pump suction level line. Equip the mixing machine with a water pressure system and fog type spray bar.

The mixture shall be agitated and spread uniformly in the surfacing box by means of twin shafted paddles or spiral augers fixed in the spreader box. Provide a front seal to insure no loss of the mixture at the road contact point. The rear seal shall act as a final strike off and shall be adjustable. The spreader box and rear strike off shall be so designed and operated that a uniform consistency is achieved to produce a free flow of material to the rear strike off. The spreader box shall have suitable means provided to side shift the box to compensate for variations in the pavement geometry. A secondary strike off shall be provided to improve surface texture. The secondary strike off shall have the same adjustments as the spreader box. Use a spreader box that is capable of producing a uniform surface up to 4.3 m (14 ft) in width.

Ruts that are 12.5 mm (0.5 in.) or greater in depth shall be filled with a rut filling spreader which is 1.5 to 1.8 m (5 to 6 ft) wide. The rut box shall be designed to provide variable depth control, be double chambered, and shall include fixed hydraulic augers in the box. The augers shall be set at an angle that will move the mixed material from the rear to the front of the filling chamber. The augers shall move larger aggregate material to the deepest portion of the rut and move the fine material toward the edges of the pass.

Provide lighting for all equipment used.

Give notification a minimum of 72 hours prior to the calibration of each mixing unit. Perform the calibration of each mixing unit within 24 hours prior to commencing micro-surfacing application. Provide facilities and furnish all necessary equipment, personnel, and materials needed to calibrate and verify each mixing unit including the aggregate weight systems, emulsion metering devices, and mineral filler metering devices. Calibrate each mixing unit by approved methods at each project location and verify calibration as directed. Recalibrate each mixing unit after material changes and when there is repair or replacement of equipment components.

Submit a calibration report for each mixing unit calibration and recalibration for approval prior to commencing operations. Include in the calibration report the mixing unit designation, date calibration was performed, emulsion source and type, mineral filler source and type, and aggregate source and gradation. Include in the calibration report the delivery rate of aggregate in kg (lb) per count of the head pulley, the delivery rate of emulsion in kg (lb)

per count of the head pulley, and the delivery rate of mineral filler in kg (lb) per count of the mineral filler counter. Submit graphs, measurements, and calculations used to determine the information in the report. Use the data from the aggregate, emulsion, and mineral filler calibrations to accurately set the mixing units to the optimum settings that will achieve the desired material proportions according to the approved mix design.

**418.03.02 Preparation of Surface.** Immediately before applying the micro-surfacing mixture, thoroughly clean the surface. Remove loose material, vegetation, and other objectionable material by sweeping with self propelled pick up sweeper supplemented by hand brooms if necessary. Remove loose material in cracks. Water flushing will not be permitted. Perform removal of pavement markings as provided for in Section 202.

Protect manholes, valve boxes, drop inlets, curbs, gutters, and other facilities as directed by covering with paper, plastic, or other suitable material prior to the surfacing application. Remove material covering within 24 hours after the micro-surfacing has cured.

Do not begin the application of the micro-surfacing until the surface has been properly prepared and approved.

**418.03.03 Mixture Preparation.** Ensure that all oversized aggregate particles and other objectionable matter is removed from the mineral aggregate. Screen the aggregate through a 12.5 mm (0.5 in.) screen prior to loading into the mixing unit. If approved, temporary use of screens attached to the distributor box may be permitted.

**418.03.04 Water Fog.** If road conditions require, and as directed, wet the surface by fogging immediately prior to applying the mixture. Wet the surface such that the entire surface is damp with no apparent flowing water in front of the spreader box. Adjust the rate of application during the day to suit temperatures, surface texture, humidity, and dryness of the pavement surface.

**418.03.05 Application.** Prior to the start of work, place a test section of at least 1,250 $m^2$ (1,500 $yd^2$) in a designated area. Place the test section using the same equipment, methods, and mixes as scheduled for use on the project. After placement of the test section, cease micro-surfacing application for a minimum of three days to allow for evaluation of the test section. Working days will not be charged during the evaluation period.

Test sections not conforming to the requirements of the plans and specifications will be rejected and shall be removed from the roadway and disposed of according to Subsection 107.14. Make necessary adjustments to the mix design, equipment, and placement methods and construct additional test sections, as specified above, until the surfacing meets requirements. Do not start permanent surfacing application until given approval. Test sections conforming to the plans and specifications will be considered as permanent micro-surfacing and will be measured for payment as specified in Subsection 418.04.01.

An approved mixture shall be homogeneous, sufficiently stable during the entire mixing/spreading period so that the emulsion does not break prematurely, free of segregation of the fines from the coarser aggregate, and shall have a liquid portion of the mix that does not float to the surface. Introduce the set control additive into the mixture by an approved method that will assure uniform distribution and proper control. Use water as indicated by the mix design. The mixture shall show no signs of uncoated aggregate, streaking, or premature breaking of emulsion when applied to the pavement surface.

Specified ruts, cuts, and depressions in the pavement surface will require an application of the micro-surfacing mixture using the rut filling spreader box prior to full width application. The limits of these irregular areas will be shown in the contract. Place the preliminary applications of micro-surfacing mixture in courses not exceeding 20 mm (0.75 in.) in thickness to restore the existing roadway cross section or level the pavement surface. Allow traffic on each course for a minimum of two days between successive applications.

Feed sufficient quantities of the micro-surfacing mixture into the spreader box so that uniform and complete coverage of the pavement is obtained. Operate the mixing machine at such a speed that the mixture in the spreader box does not exceed a total mixing time of 4 minutes and the volume remains constant. Place the micro-surfacing mixture at a rate of 14 kg of dry aggregate per square meter (25 pounds of dry aggregate per square yard) unless otherwise specified. Application rates adjusted for smooth or rough pavement surface textures may be applied outside of the specified range, as approved.

Do not leave any streaks caused by oversized aggregate particles or buildup of micro-surfacing mix on squeegees in the finished surface. If excessive streaking develops, cease operations until the situation has been corrected. Excessive streaking is defined as more than four drag marks greater than 12.5 mm (0.5 in.) wide and 100 mm (4 in.) long, or 25 mm (1.0 in.) wide and 75 mm (3 in.) long, in any 23 $m^2$ (27 $yd^2$) area. Transverse

ripples or longitudinal streaks of 5 mm (0.2 in.) in depth or more will not be allowed, when measured by placing a 3.6 m (12 ft) straightedge over the surface.

Place the mixture such that edge lines are straight along all curbs, gutters, and shoulders. Runoff will not be allowed. Lines at intersections shall be straight.

Compact rut filling applications and other areas as directed with a minimum 3.6 metric ton (4 ton) and a maximum 9 metric ton (10 ton) pneumatic tired roller when material is set sufficiently. Roll a minimum of 2 coverages and until a uniform surface is obtained.

Submit a signed written report each working day indicating the amount of aggregate and emulsion delivered, aggregate and emulsion used on the project, the amount of area in square meters (square yards) completed, the percentage of emulsion used to aggregate used, the application rate in kilograms of aggregate applied per square meter (pounds of aggregate applied per square yard) of area covered, and the type of additive used.

**418.03.06 Joints.** Place longitudinal joints on the lane lines. Do not allow excessive build-up, uncovered areas, or unsightly appearance on longitudinal or transverse joints.

The longitudinal joint between adjacent lanes shall be butt joints with overlaps not to exceed 75 mm (3 in.). Butt joints shall have no visible lap, pinholes, or uncovered areas. Immediately smooth thick spots caused by overlapping with hand squeegees before the emulsion breaks. Smooth overlaps which occur at transverse joints before the emulsion breaks so that a uniform surface, which contains no discontinuities, is obtained.

When a 3.6 m (12 ft) straightedge is laid perpendicular across any joint, the finished surface shall not deviate at any point more than 6 mm (0.25 in.) from the bottom thereof.

**418.03.07 Hand Work.** Use hand squeegees with burlap drags to spread the mixture in areas not accessible to the spreader box. Exercise care in leaving no unsightly appearance from the work. Remove all runoff on the curb and gutters, and other areas as directed, using approved methods.

**418.03.08 Curing.** Allow areas receiving micro-surfacing to cure at least one hour or until the treated pavement will not be damaged by traffic. Protect the area from traffic for the full curing period. Repair areas that are damaged within 24 hours of application of micro-surfacing prior to moving to new work locations.

**418.03.09 Sweeping.** Five days after micro-surfacing application, sweep surfaced areas to remove excess raveled material that becomes dislodged. Dispose of dislodged material according to Subsection 107.14.

**418.03.10 Weather Limitations.** Do not apply micro-surfacing mixture unless both the pavement and air temperatures are 13 °C (55 °F) and rising. Do not apply micro-surfacing mixture when there is forecast of the atmospheric temperature dropping below 0 °C (32 °F) within 24 hours of placement. Do not apply the micro-surfacing mixture when precipitation is imminent. Do not apply micro-surfacing mixture when the surface temperature exceeds 46 °C (115 °F) or when the atmospheric temperature exceeds 35 °C (95 °F).

## METHOD OF MEASUREMENT

**418.04.01 Measurement.** Micro-surfacing emulsion and micro-surfacing aggregate will be measured by the metric ton (ton).

## BASIS OF PAYMENT

**418.05.01 Payment.** The accepted quantities, measured as provided above, will be paid for at the contract price per unit of measurement for the pay items listed below that are shown in the proposal. Payment will be full compensation for the work prescribed in this Section.

Payment will be made under:

| Pay Item | Pay Unit |
|---|---|
| Micro-Surfacing Emulsion (type) | Metric Ton (Ton) |
| Micro-Surfacing Aggregate (type) | Metric Ton (Ton) |

# SECTION 501

## PORTLAND CEMENT CONCRETE

### DESCRIPTION

**501.01.01 General.** This work consists of proportioning, placing, and curing Portland cement, aggregates, water, and when specified, admixtures.

### MATERIALS

**501.02.01 General.** Materials shall conform to the following Sections:

| | |
|---|---|
| Portland Cement | Section 701 |
| Concrete Curing Materials and Admixtures | Section 702 |
| Aggregates for Portland Cement Products | Section 706 |
| Water | Section 722 |

**501.02.02 Aggregates.** Produce and stockpile adequate quantities of aggregate sufficiently in advance of construction operations as to permit sampling, testing, and mix designs before use.

Give not less than 32 days notification in advance of use of the proposed sources of materials and make arrangements for the Engineer to obtain samples as required for testing purposes.

When requested, exceptions to the above requirement may be granted in writing when the aggregate source has been previously tested within the past one year and accepted by the Department.

When producing Portland cement concrete, use the same aggregates used in the approved mix design.

Store aggregates in stockpiles sufficiently removed from each other to prevent the materials at the edges of piles from becoming intermixed, and to allow sampling by heavy equipment.

Use lightweight aggregates specified in Subsection 706.03.02 only where lightweight concrete is specified or is approved.

For Class E and EA concrete, use a three aggregate system consisting of a blend of two Coarse Aggregates from Subsection 706.03.01 and Fine Aggregate conforming to Subsection 706.03.03. If approved, the 25 mm (1 in.) combined grading limits may be used in lieu of the 19 mm (3/4 in.) combined grading limits. Use American Concrete Institute, Manual of Concrete Practice, Guide 302.1R-04, Section 5.4.3 Combined Aggregate Grading to optimize the combined aggregate grading within the grading limits in Subsection 706.02.01. Submit the results with the mix design.

Provide necessary means to obtain an aggregate sample from the batch plant conveyor belt. Construct the sampling device so representative samples may be taken as required. Deliver the samples by mechanical means to a point on the ground or other satisfactory safe and accessible location.

If two consecutive sieve analysis results are out of specification, reprocess the failing stockpile or stockpiles. If three consecutive sieve analysis results are out of specification, the stockpile or stockpiles will be rejected. Once rejected material has been replaced, provide test results indicating the new material is within specification.

The gradation requirements represent the extreme limits in determining the suitability of material. Maintain the gradation from any one source, for any one contract, at a uniformity such that variations in the fineness modulus will not exceed ± 0.2 from the “Base Fineness Modulus.” The “Base Fineness Modulus” shall be the average of the most recent 10 fineness modulus values (or the average of all preceding values if less than 10 have been completed) from any one source, for any one contract. Fine aggregate from any one source, for any one contract, having a variation in fineness modulus of more than 0.2 as prescribed above will be rejected or may be accepted subject to approved changes.

**501.02.03 Cement.** Use Type V cement with a minimum of 20% pozzolan by mass in all concrete. In lieu of this requirement, Type II cement with a minimum of 20% pozzolan by mass or Type IP cement may be substituted therefore.

For Class S and SA concrete, the maximum shrinkage requirement of 0.06% in 28 days air dry after 28 day wet cure (ASTM C157) shall apply if the amount of cement exceeds 450 kg/m$^3$ (752 lb/yd$^3$), excluding drilled shaft applications.

**501.02.04 Admixtures.** Use admixtures according to manufacturer's recommendations and as incorporated into the approved mix design.

Do not add water to the concrete once the water reducing admixture has been incorporated into the mix.

Do not use admixtures that were not incorporated into the approved mix design. If approved, an exception may be allowed for an admixture intended to retard setting time.

Do not use admixtures containing chlorides as CL– in excess of 1% by mass in prestressed concrete.

If admixtures are used to reduce the water-cement ratio or to accelerate setting time, use them at the rate of dosage specified on the mix design.

When a Type F High Range Water Reducer is used, the slump requirements of Table I of Subsection 501.02.05 are hereby waived and the slump of the concrete after the admixture is added shall not exceed 200 mm (8 in.).

Dispense chemical admixtures in liquid form.

Use all low and mid-range water reducing admixtures (Type A, D, and E) only in dosages as specified on the mix design.

Use high range water reducing admixtures (Type F and G) designated on the mix design which may be varied within the manufacturer's recommendations to achieve the desired slump within the specified limits.

When water-reducing agents or water-reducing retarders are used, do not exceed the dosage of the admixture which will result in an increase in the drying shrinkage of the concrete in excess of 20% when used in precast, prestressed concrete; 10% when used in cast-in-place prestressed concrete; 10% when used in cast-in-place reinforced concrete; or 3% when used in non-reinforced concrete pavements.

Do not use set retarders in dosages greater than those recommended by the manufacturer, nor more than that needed to obtain the desired retardation.

Store pozzolan in separate weather-tight facilities.

In lieu of the 20% minimum addition of pozzolan, slag cement will be permitted as a mineral admixture. Use a minimum of 35% slag cement. Class F pozzolan may be used in conjunction with slag cement at a rate of 15% by mass of the total cementitious material. The maximum total mineral admixture substitution shall be 50% of the mass of the total cementitious material.

Silica fume conforming to Subsection 702.03.06 may be used to replace 3% to 7%, by mass, of the total cementitious material.

After the concrete has been batched and delivered to the project, only one attempt may be made, by adding approved admixtures, to bring the slump and air content into specification as specified in Table I of Subsection 501.02.05. Do not add water to the mix after water reducing admixtures are added onsite.

**501.02.05 Concrete Making Properties.** Portland cement concrete will be tested according to the following test methods:

| Test | Test Method |
|---|---|
| Compressive Strength of Molded Concrete Cylinders (a) | ASTM C39 |
| Making and Curing Test Specimens in the Laboratory | ASTM C192 |
| Making and Curing Concrete Compression Test Specimens in the Field | Nev. T428 |
| Unit Weight, Volume and Cement Factor | Nev. T435 |
| Air Content (b) | Nev. T431 or T432 |
| Aggregate Correction Factor | ASTM C231 |
| Specific Gravity and Absorption of Coarse Aggregate | Nev. T492 |
| Specific Gravity and Absorption of Fine Aggregate | Nev. T493 |
| Slump (c) | Nev. T438 or Nev. T439 |
| Slump Flow | Nev. T417 |
| Passing Ability (J-Ring) | Nev. T418 |
| Visual Stability Index, VSI | Nev. T417 |
| Coring Concrete | ASTM C42 |
| Length of Drilled Cores | ASTM C174 |

(a) The compressive strength will be based on the average strength of 3 cylinders at 28 days.
(b) Referee or dispute testing shall be performed using Test Method No. Nev. T431.
(c) Unless otherwise required, Test Method No. Nev. T438 will be used.

Design and produce concrete mixtures that conform to Table I for the class of concrete specified.

**TABLE I**

| Class of Concrete | Cement Range kg/m$^3$ (lb/yd$^3$) | Grading Limits of Combined Aggregates mm (in.) | Maximum Water Cement Ratio kg/kg (lb/lb) | Minimum Compressive Strength MPa (psi) | Slump Range mm (in.) | Entrained Air Range % |
|---|---|---|---|---|---|---|
| A and AA | 330-420 (564-705) | 37.5 (1 1/2) | 0.45 (0.45) | 21 (3000) | 25-100 (1-4) | 4-7 (AA only) |
| B<br>BA | 300-420 (517-705)<br>300-420 (517-705) | 37.5 (1 1/2)<br>37.5 (1 1/2) | 0.47 (0.47)<br>0.47 (0.47) | 21 (3000)<br>21 (3000) | 25-125 (1-5)<br>25-100 (1-4) | ---<br>4-7 |
| C<br>CA | 280-360 (470-611)<br>300-390 (517-658) | 37.5 (1 1/2)<br>37.5 (1 1/2) | 0.60 (0.60)<br>0.51 (0.51) | 17 (2500)<br>17 (2500) | 25-125 (1-5)<br>25-125 (1-5) | ---<br>4-7 |
| D<br>DA | 330-420 (564-705)<br>330-450 (564-752) | 19 (3/4) *<br>19 (3/4) * | 0.45 (0.45)<br>0.45 (0.45) | 21 (3000)<br>21 (3000) | 25-100 (1-4)<br>25-100 (1-4) | ---<br>4-7 |
| PAA | 330-450 (564-752) | 19 (3/4) * | 0.45 (0.45) | See Plans | 25-100 (1-4) | See Plans |
| A and AA Modified | 330-450 (564-752) | 37.5 (1 1/2) | 0.45 (0.45) | See Plans | 25-100 (1-4) | 4-7 (AA only) |
| D and DA Modified | 330-450 (564-752) | 19 (3/4) * | 0.45 (0.45) | See Plans | 25-100 (1-4) | 4-7 (DA only) |
| E and EA Modified | 330-420 (564-752) | 19 (3/4) | 0.40 (0.40) | See Plans | 13-100 (1/2-4) | 4-7 (EA only) |
| S and SA | 380-545 (639-925) | 19 (3/4) * | 0.40 (0.40) | 28 (4000) | N/A | 4-7 (SA only) |
| PCCP | 360-420 (611-705) | See 409.02.01 | 0.45 (0.45) | 28 (4000) | 25-125 (1-5) | 4-7 |

* If approved, 25 mm (1 in.), 12.5 mm (1/2 in.), or 9.5 mm (3/8 in.) grading limits may be used in lieu of 19 mm (3/4 in.).

The maximum water/cement ratio is based on aggregate in a saturated surface dry condition.

Using the weight in pounds of each material, calculate the water cement ratio (w/c) by the following equation:

*w/c = water/ (cement + cement substitutes + mineral admixtures)*

The water actually used is determined by the water measured into the batch plus any free water on the wet aggregate.

The combined mass of cement and mineral admixtures will be considered as the mass of the cement when determining compliance with the cement range and maximum water/cement ratio requirements.

For extruding barrier or bridge rail, the slump range is 12.5 mm to 100 mm (0.5 in. to 4 in.).

Furnish a concrete mix design stamped by a Professional Engineer registered in the State of Nevada. Submit the mix design for approval at least 20 working days before the start of production.

The concrete mix design shall include the following information:

1. Contract or Project Number.
2. Name and address of concrete producer/supplier along with the plant location.
3. Concrete producers/suppliers unique mix design identification number.
4. Class of concrete.
5. Date when mix design was last updated.
6. Minimum 28 day strength requirement.
7. Water/cement ratio.
8. Type of cement, including cement substitutes. Include the specific gravity of each material.
9. Slump (If applicable report design slump before and after addition of admixtures).
10. Air content (if required).
11. Name and location of material sources for cement, cement replacement, water, aggregate, and admixtures. Include the name of the lab and date of testing performed on materials.
12. Sieve analysis for each individual primary aggregates nominal size and the combined gradation of aggregate proportions mathematically combined.
13. Absorption, bulk specific gravity and individual percentage of aggregates used.
14. Aggregate Correction Factor (if required).
15. Fineness modulus of fine aggregate.
16. Individual and total batch content of all mix components used in mass per volume [kg/m$^3$ (lb/yd$^3$)] and volume per volume [m$^3$/m$^3$ (ft$^3$/yd$^3$)] of concrete. Aggregate weights shall be shown in SSD condition.
17. Theoretical unit weight of plastic concrete in kg/m$^3$ (lb/ft$^3$).
18. Name, type, and dosage amounts of admixtures.
19. Current material certificates for cement, cement substitute, and admixtures used.
20. Sieve analysis data performed and signed by an accredited lab for each individual primary aggregates nominal size.
21. Accelerated Detection of Potentially Deleterious Expansion of Mortar Bars Due to Alkali-Silica Reaction.

As an option, in order to adjust any admixture dosage, with the exception of an air entrainment admixture, and change mixture properties, submit two mix designs, one with the minimum and one with the maximum dosage of admixtures proposed, within the manufacturers recommended range. Select an admixture dosage from the approved range for production of concrete. If electing to adjust the admixture dosage, give written notification prior to batching concrete.

Accelerator admixtures that were not included in the mix design and used in the trial batch cannot be used in the mix. Perform a new mix design and trial batch including the necessary adjustment to the water/cement ratio.

Verify the mix design with a trial batch prepared from the same sources proposed for use.

If a trial batch is performed, identify whether it was produced in a lab or at a batch plant. At a minimum include the size of batch, date produced, unique mix identification number, class of concrete, admixture name, type, and dosage amounts used. Show individual and total batch content of all mix components used in mass per volume [kg/m$^3$ (lb/yd$^3$)] and volume per volume [m$^3$/m$^3$ (ft$^3$/yd$^3$)] of concrete. Aggregate weights shall be shown in SSD condition. Include the concrete property test results performed on the trial batch listed in Table I. Identify the manufacturer of all admixtures along with the dosage amounts used. The age and date at the time of testing that includes the individual and combined compressive strength of all concrete cylinders in MPa (psi). The report shall be signed by an official of the accredited firm who performed the tests. At a minimum, the compressive strength tests shall include 5 standard cylinders tested at 7 and 28 days, taken from a single batch that included all the mix design ingredients, has a combined strength at least 15% greater than the specified 28 day compressive strength, and no individual cylinder shall have a strength that is less than the specified strength. Pending the 28 day strength results, mix designs may be approved on the basis that 5 combined standard cylinders tested at 7 or 14 days meets or exceeds the 28 day target strength requirement and that no other required tests are pending. Supply trial batch test data no later than 20 working days before its proposed use.

Generate a trial batch that conforms to the mix design proportions and properties.

Use accredited laboratories to produce trial batches or to sample the batch from the same plant that will produce the concrete. Accreditation shall be obtained from the American Association of State Highway and Transportation Officials (AASHTO) or the American Association for Laboratory Accreditation (A2LA).

The minimum required test methods and procedures the certificate of accreditation shall include are: ASTM C1077, C31, C39, C40, C117, C127, C128, C136, C138, C143, C172, C173, C192, C617, or AASHTO equivalents. Accreditation will also be required for specific tests as specified herein. Accreditation will be verified from the AASHTO or A2LA website.

In lieu of performing a trial batch, ten consecutive test results from a mix design previously approved by the Department and used on a local municipality or State project within the last 12 months may be submitted for approval. Include all of the required information above including the plastic concrete properties of the mix that was sampled for break data, as listed in Table I.

Submit a new mix design and trial batch data when any change is made to the ingredients of the original design. The new mix design shall have a new and unique number.

The Department may verify any or all properties of the concrete mix design or individual component properties prior to mix design approval or during production of the contract. The Department will notify the Contractor when a mix design will be verified. A Department representative will sample the components for verification and perform testing. If the Department deems there is a significant change in properties, a new mix design and trial batch will be required.

Be responsible to obtain an approved mix design that meets the requirements of the specifications and is appropriate and suitable for the intended use. The Department reserves the right to discontinue the use of any approved mix design during the life of the contract/project if deemed detrimental, inferior, or unacceptable for use.

The 28 day design compressive strength from the approved mix design will serve as the required compressive strength of the concrete. The mix design strength will be the basis for acceptance even when the contract documents specify lower compressive strengths.

Produce trial batches only from supplies of aggregates produced, stockpiled, and approved for use on the project. Trial batches produced from material sampled from deposits and artificially processed to simulate processing methods will not be accepted.

Perform all tests for prequalification according to either the appropriate Nevada test method or the comparable ASTM or AASHTO test methods. Use testing equipment in good condition and properly calibrated.

## CONSTRUCTION

**501.03.01 Equipment.** Maintain the equipment in good condition and adjustment.

Provide adequate internal vibrating equipment, including power, to enable fabrication of concrete cylinders for testing purposes.

Furnish internal vibrators with rigid or flexible shafts, preferably powered by electric motors, capable of operating at a frequency of 7,000 vibrations per minute or greater. The outside diameter or the side dimensions of the vibrating element shall be at least 19 mm (3/4 in.) and not greater than 38 mm (1 1/2 in.). The length of the shaft shall be at least 600 mm (24 in.).

**501.03.02 Protecting and Sampling Cement.** Provide suitable means of storing and protecting the cement against moisture or other injurious effects. Sacked or bulk cement which has become partially set or which contains lumps of caked cement will be rejected and shall be immediately removed from the work site.

Do not mix different brands of cement during use or in storage, nor use alternately in any one structure. Use the same brand and kind of cement in a given structure above the ground line.

Pile the sacked cement as to permit access for tally, inspection, and identification of each shipment.

Obtain from the cement company, a certificate stating that the cement delivered to the work complies with the specifications for the type of cement specified for use. Deliver 2 copies of the certificate which is dated, signed, and indicates the quantity of shipment.

Upon receipt of the Certificate of Compliance, the Engineer may permit the use of the cement.

When a Certificate of Compliance is not furnished, do not use the cement in the work until the material has been tested and approved. Allow 14 days for the Department to test previously approved brands of cement in common use, and 28 days to test new or previously unapproved brands of cement.

If it is determined by subsequent laboratory tests of mill or field samples that the cement does not comply with the specifications, discontinue use of mix designs containing the failing cement until tests can be made on each lot of cement delivered.

Remove from the work any cement not conforming to the specifications, or damaged by exposure to moisture.

**501.03.03 Storage of Aggregates.** Perform the handling and storage of aggregates as to prevent segregation or contamination by foreign materials. Discontinue storage or transportation methods which cause the segregation, degradation, or the combining of material.

If the aggregate for a concrete mixture is to be a composite material from 2 or more sources, proportion material from respective sources separately or blend by methods which will maintain the gradation required.

Before use, add moisture to the aggregate stockpiles to provide a fully saturated condition ensuring complete absorption of water. As necessary before batching, stop the application of water to the stockpiles so that the aggregates are at or above saturated surface dry condition when they are incorporated into the batch. Test the aggregates to determine the amount of free water on the aggregate and adjust the addition of mix water accordingly during batching. Do not use aggregates that show visible separation of water and aggregates during transportation from the stockpile to the batch plant.

**501.03.04 Proportions.** Batch concrete to within the following tolerances from the approved mix design:

| Constituent | Tolerance |
|---|---|
| Cement | ± 1% |
| Water | |
| Holdback Water | - 10% |
| Additional Water | + 1% |
| Mineral Admixture | ± 1% |
| Liquid Admixture* | ± 5% |
| Individual Aggregate Weight | ± 1.5% |
| Combined Aggregate Weight | ± 1% |
| Unit Weight | ± 50 kg/m$^3$ (3 lb/ft$^3$) |

* This tolerance does not apply to addition of admixtures for air entrainment and high range water reducers intended to increase slump.

**501.03.05 Proportioning Methods.** Use aggregate bins that conform to either of the following:

1. Store each specified size of aggregate in a separate bin. Provide each bin with an individual outlet gate, designed and constructed to prevent leakage when closed. Design the gates to cut off quickly and completely.

2. Weigh each size aggregate individually in a single bin. Provide a satisfactory method to eliminate any excess material resulting from over-charging of the bin before the material reaches the surge hopper.

Store each mineral admixture in a separate silo. Weigh each mineral admixture separately from the aggregates. When using silica fume, submit for approval, a procedure outlining how silica fume will be weighed and introduced to the mixing drum during the batching process.

Proportion aggregates by mass, with the exception that aggregates for culvert headwalls, short pieces of curbs and gutter, or small sections of sidewalk and related minor work may be proportioned either by mass or volume. Furnish and use measuring boxes of known capacity to measure each size of aggregate proportioned by volume.

Proportion batch water to account for free moisture and varying absorption values for both coarse and fine aggregate stockpiles. Submit a new mix design if either the coarse or fine aggregate absorption values vary from the approved mix design by more than 1%.

Keep the scale and weigh hopper for the cement separate and distinct from the aggregate hopper or hoppers. Interlock the discharge mechanism of the bulk cement hopper against opening before the full amount of cement is in the hopper, against closing before the contents of the hopper are entirely discharged and the scales are back in balance, and against opening when the amount of cement in the hopper is under mass by more than 1% of the amount specified.

Accurately measure admixtures into each batch by approved methods. Use admixture dispensers with sufficient capacity to measure at one time the full quantity required for each batch. Unless liquid admixtures are added to premeasured water for the batch, arrange their discharge into the batch to flow uniformly into the stream of water.

Design equipment for measurement for convenient confirmation of the accuracy of measurement. If more than one liquid admixture is used, dispense each by separate equipment unless otherwise permitted in writing.

Scales utilized in the proportioning device may be of the springless dial type or of the multiple beam type.

If scales are the dial type, size and arrange the dial so it may be read easily from the operating platform.

If scales are the multiple beam type, provide the scales with an indicator operated by the main beam which will give positive visible evidence of over or under mass. Design the indicator so that it will operate during the addition of the last 180 kg (400 lb) of any weighing. The over travel of the indicator hand shall be at least 1/3 of the loading travel. Enclose the indicator against moisture and dust.

Insulate weighing equipment against vibration or movement of other operating equipment in the plant.

Use approved scales with a Certificate of Inspection as required in Subsection 109.01.

Construct batch trucks hauling more than one batch of cement and aggregate so that materials do not flow from one compartment to another during haul or discharge.

Handle and measure coarse and fine aggregate separately. Empty cement directly into charging skip of the mixer.

Measure water by volume or by mass.

Use tanks or other equipment sufficiently accurate for measuring and discharging water into the mixer so that the amount of water delivered to the mixer for any batch shall not vary more than 1% from the required quantity of water for any position of the mixer with respect to level plane. Arrange the tanks or other equipment so as to permit the checking of the amount of water delivered by discharging into measured containers. Discharge water rapidly in one operation into the mixing drum without dribbling. Design the equipment so that water from the source of supply cannot enter the measuring tank while the water is being discharged from the measuring tank into the mixer.

**501.03.06 Mixing.** Attach permanent legible plates on mixers showing manufacturer's rated capacity, mixing speeds, and serial number.

Mixers may be stationary mixers or truck mixers. Agitators may be truck mixers operating at agitating speed or truck agitators. Attach a metal plate or plates on each mixer and agitator in a prominent place on which is plainly marked the various uses for which the equipment is designed, the manufacturer's guaranteed capacity of the drum or container in terms of the volume of mixed concrete and the speed of rotation of the mixing drum or blades.

Furnish samples of the fresh concrete and provide safe and satisfactory facilities for obtaining the samples.

Concrete mixers may be of the revolving drum or the revolving blade type. Operate the mixing drum or blades uniformly at the mixing speed recommended by the manufacturer.

Maintain the temperature of materials as charged into the mixer such that the temperature of the mixed concrete at the time it is placed in final position is not less than 10 °C (50 °F) nor more than 32 °C (90 °F) as specified in Subsection 501.03.09 (b). Aggregates and water used for mixing shall not exceed 65 °C (150 °F).

Mix concrete for structures for a period of not less than 1 minute nor more than 5 minutes after all materials, including water, are in the mixer.

Batch and charge cement into the mixer by means that will not result either in loss of cement due to the effect of wind, or in accumulation of cement on surfaces of conveyors or hoppers, or in other conditions which reduce or vary the required quantity of cement in the concrete mixture.

Do not exceed 30 minutes total elapsed time between the intermingling of damp aggregates and cement and the start of mixing.

Do not use mixers and agitators which have an accumulation of hard concrete or mortar or worn blades.

Completely discharge wash water from the drum or mixing container before the succeeding batch is introduced.

When central-mixed concrete is furnished and non-agitating hauling equipment is used for transporting concrete to the delivery point, for Portland cement concrete pavement, complete discharge into the concrete paver within 45 minutes after the addition of the cement to the aggregates.

When mixing at the site of the work, use mixers of the paving or stationary type. Do not exceed the rated capacity of mixers as determined by the manufacturer.

Ready-mixed concrete includes central-mixed, shrink-mixed, and transit-mixed concrete. Shrink-mixed concrete is concrete that has been mixed partially in a stationary mixer and the mixing completed in a truck mixer.

Do not exceed the rated capacity in truck mixers and truck agitators as determined by the manufacturer.

Store approved cement at the concrete plant in such a manner that it can be identified and kept separate from other cement.

Transport ready-mixed concrete for structures in truck mixers or truck agitators.

The mixer, when loaded to capacity, shall be capable of combining the ingredients of the concrete into a thoroughly mixed and uniform mass within the specified time, and of discharging the concrete with a satisfactory degree of uniformity. The agitator, when loaded to capacity, shall be capable of maintaining the mixed concrete in a thoroughly mixed uniform mass and of discharging the concrete with a satisfactory degree of uniformity.

Mixers and agitators will be examined periodically for accumulation of hardened concrete or mortar or to wear of the blades. If accumulation or wearing is detected, correct the faulty equipment before further use.

Equip truck mixers with electrically or mechanically actuated revolution counters by which the number of revolutions of the drum or blades may be readily verified. Use counters of the continuous-registering, non-resettable type, which accurately register the number of revolutions, and mount on the truck mixer so that the Engineer may safely and conveniently inspect them from alongside the truck.

When a truck mixer is used, mix each batch for not less than 70 nor more than 100 revolutions of the drum or blades at the rate of rotation designated by the manufacturer of the equipment as mixing speed. If additional mixing is done, mix at the speed designated by the manufacturer of the equipment as agitating speed. Do not exceed a total of 320 revolutions from the time of initial batching to complete discharge of delivered concrete.

When shrink-mixed concrete is furnished, all requirements for transit-mixed concrete shall apply. No credit in the number of revolutions at mixing speed will be allowed for partial mixing in a central plant.

Upon delivery to the job site, if an admixture or additional water is incorporated into the concrete, revolve the drum not less than 45 revolutions at mixing speed or until a homogeneous mixture is obtained.

Control the rate of discharge of mixed concrete from truck mixer-agitators by the speed of rotation of the drum in the discharge direction with the discharge gate fully open.

When truck mixer or truck agitator is used for transporting concrete that has been completely mixed in a stationary mixer, mix during transportation at the agitating speed designated by the manufacturer of the equipment.

When a truck mixer or agitator is used for transporting concrete, deliver the concrete to the site of the work and complete discharge within 90 minutes after the introduction of the mixing water to the cement and aggregates, or the introduction of the cement to the aggregates. In hot weather or under conditions contributing to quick stiffening of the concrete, a delivery time of less than 90 minutes may be required. When a truck mixer is used for the complete mixing of the concrete, begin the mixing operations within 30 minutes after the cement has been intermingled with the aggregate.

A request in writing may be submitted for approval to exceed the specified 90 minute time limit for the discharge of the concrete. Include the maximum time limit requested, the name and dosage rate of the admixture, and the identification of the mix design with which the admixture will be used. Design the admixture specifically for the purpose of controlling slump loss and temperature increase, by stopping or slowing the rate of hydration of the cement. A new mix design and/or a new trial batch may be required before approval. The request will be considered only when the mixing plant is such a distance from the site of work that it is not practical to have the mixed concrete delivered and placed within the 90 minute time limit.

All other requirements of the specifications shall remain in effect when using the admixture, including slump and temperature requirements.

If the mixing plant is so located from the site of the work that is not practical to have mixed concrete delivered and placed in forms within the time limit specified, submit a proposal for the delivery method of the concrete.

Use a concrete supplier and batch plant that has sufficient plant capacity and transport vehicles to insure continuous delivery at the rate required. Provide a rate of delivery of concrete such as to allow for the proper handling and placing of concrete. Do not allow an interval of more than 45 minutes between any 2 consecutive batches or loads. Maintain a delivery and placing rate of not less than 6 $m^3$ (8 $yd^3$) of concrete per hour on work other than new bridge decks. Maintain a delivery and placing rate of not less than 6 m (20 ft) per hour on new concrete bridge decks. For Class S and SA concrete, place each successive batch within a maximum interval of 20 minutes. If failing to adhere to this requirement, work will be shut down for the remainder of the shift. If so ordered to shut down, make a construction joint at the location and of the type directed.

After mixing of ready-mixed concrete has been completed, agitate it continuously at agitating speed until it has been discharged from the drum. Concrete with unmixed lumps of cement in the mixed product will be rejected.

Use a batch ticket system for recording each load of concrete delivered to the project. Batch tickets shall include the ticket number, date and time of batching, weight of each constituent used (actual and design), and aggregate moisture (free and absorbed). Issue tickets to the truck operator at the plant and deliver them to the Department inspector at the site of the work. Loads that arrive at the jobsite without batch tickets will be rejected.

**501.03.07 Retempering.** Mix concrete only in such quantities as are required for immediate use and place before initial set has taken place. Waste concrete in which initial set has begun. Do not retemper concrete.

**501.03.08 Curing.** Cure concrete for the length of time hereinafter specified.

Cure all bridge decks and approach slabs according to (d) Bridge Deck Curing.

Commence curing immediately upon completion of the finish. In the event that the application or placement of the curing medium is delayed, fog as described below until curing method is applied.

Use fogging equipment capable of applying water through an atomizing nozzle in the form of a fine mist, not a spray. The equipment may use water pumped under adequate high pressure, or a combination of air and water pumped under high pressure. Use equipment sufficiently portable for use in the direction of any prevailing wind. Adapt equipment for intermittent use as directed to prevent excessive wetting of the concrete.

(a) Curing Compound Method. Uniformly spray the entire surface of the concrete with an approved curing compound conforming to Subsection 702.03.01, except as hereinafter specified for concrete bridge decks and approach slabs. Apply the curing compound to the exposed surface at a uniform minimum rate of 0.27 L/$m^2$ (1 gal/150 $ft^2$) of area and according to the manufacturer's recommendations.

Hold foot traffic to a minimum and do not use these surfaces as a work area during the cure period. Immediately repair damaged portions of the curing film with additional compound before the expiration of 7 days.

Deliver the curing compound to the work in ready-mixed form. At the time of use, supply the compound in a thoroughly mixed condition with the pigment uniformly dispersed throughout the vehicle. Do not dilute or alter the compound in any manner after manufacture, unless dilution is recommended by the manufacturer.

Package the curing compound in clean 208 L (55 gal) steel barrels or round 18.9 L (5 gal) steel containers or supply from a suitable storage tank located at the jobsite. Equip each 208 L (55 gal) barrel with a built-in agitator having 2 sets of blades; one at the bottom, and the second, midway between top and bottom, and with removable lids and airtight band fasteners. Keep on-site storage tanks clean and free of all contaminants. Provide each tank with a permanent system designed to completely redisperse settled material without introducing air or other foreign substances. Fill barrels in a manner that will prevent skinning. Seal 18.9 L (5 gal) containers well with ring seals and lug type crimp lids. Provide lining of the containers which will resist the solvent of the curing compound and not permit skins to be loosened into the body of the curing compound. Label each container with the manufacturer's name, batch number, type of compound, number of liters, and date of manufacture. Also label with an Interstate Commerce Commission Red Label warning concerning flammability. The label shall also warn that the curing compound shall be well stirred before use.

When the curing compound is shipped in tanks or tank trucks, supply a shipping invoice with each load containing the same information as that required herein for container labels.

Curing compound may be sampled by the Engineer at the source of supply and at the job site.

Do not use curing compound that is expired.

(b) Waterproof Membrane Method. Keep the exposed finished surfaces of concrete damp with water using an atomizing nozzle, as specified above, until the concrete has set. Place the curing membrane after the concrete has set. Form the membrane into sheets of such width as to provide a complete cover of the entire concrete surface. Securely cement joints in the sheets together in such a manner as to provide a waterproof joint. Overlap sheets a minimum of 450 mm (18 in.). Securely weigh down the sheets by placing a bank of earth on the edges of the sheets or by other satisfactory means.

Sheeting material shall conform to Subsection 702.03.01.

Keep the curing membrane in place for not less than 7 days. Immediately repair broken or damaged portions before the expiration of the curing period with new sheets properly cemented into place. Do not use sections of the membrane which have lost their waterproof qualities or have been damaged to such an extent as to render them unfit for curing.

(c) Form Method. Forms kept on concrete surfaces will be considered adequate cure. Use one of the above methods on the exposed surfaces if the forms are removed within 7 days after the concrete has been placed.

(d) Bridge Deck Curing. Use Figure 4.1 from ACI 305R, Hot Weather Concreting, to determine the evaporation rate. Provide additional protection measures if the rate of evaporation exceeds 0.1 lb/ft$^3$/hr. Provide accurate record of placement location air temperature, relative humidity, concrete temperature and wind velocity. Take readings an hour prior to the concrete placement and at fifteen minutes increments during concrete placement until the final curing blanket is placed. Submit required data as directed.

Monitor concrete temperature during the entire curing period by utilizing recording thermocouples embedded at 25 mm (1 in.) below the concrete surface and 25 mm (1 in.) above the bottom of the deck. A minimum of two sets of installations will be required per each days pour. The thermocouples shall be capable of recording the concrete temperature as a function of time and be accurate to within 1 °C (1.8 °F). Maintain a maximum temperature differential between the top and bottom thermocouples of 17 °C (30 °F). Submit the information gathered from the thermocouples.

Immediately after the concrete is finished, maintain the moisture content by continuously humidifying the air above the deck until the curing covers are placed. Use fogging equipment mounted on a finishing bridge which is separate from the concrete placing equipment.

Perform wet curing of the surface for 10 days, unless otherwise directed, using burlap conforming to Subsection 702.03.01, soaker hoses, and polyethylene conforming to ASTM C171.

Begin placing pre-soaked burlap within 30 minutes after the finishing is started. Place soaker hoses on the burlap to provide continuous wetting.

Cover the burlap and soaker with polyethylene. Lap polyethylene a minimum of 450 mm (18 in.) and seal the edges to prevent loss of heat and moisture.

Maintain the burlap in a wetted condition during the entire curing period. Water temperature shall be within 11 °C (20 °F) of the top of the bridge deck.

If the ambient temperature drops below 7 °C (45 °F) provide additional protection according to Subsection 501.03.09.

After the wet curing period, remove the wet curing materials and apply curing compound according to (a) Curing Compound Method. Maintain the moisture content of the surface of the deck until the curing compound is applied. The application rate of the bridge deck curing compound, at any point, shall be 0.30 ± 0.05 L/m$^2$ (1 gal/135 ft$^2$ ± 20 ft$^2$). Equip power operated spraying equipment for application of curing compound with an operational pressure gage and means of controlling the pressure.

If the bridge deck cracks, the Department will determine the appropriate repair method. Visual inspection, coring, or other methods may be used in the analysis. Epoxy flooding of the deck, epoxy injection of the cracks, a multilayer overlay, a polymer concrete overlay, another repair method, or a combination of repair methods may be required depending on the type and severity of the cracks. Submit a plan for accomplishing the required repair method for approval.

**501.03.09 Weather Limitations.** (a) General. Evaluate weather conditions prior to deciding whether or not to begin the pour. Before any concrete is placed, have adequate provisions readily available as approved, to protect the concrete from any impending weather conditions. In case precipitation should occur after placing operations have started, provide ample covering to protect the work. Stop the placing of concrete before the quantity of precipitation is sufficient to cause a flow or to wash the surface.

The temperature of any surface that comes in contact with fresh concrete shall be at least 4 °C (40 °F) and maintained at 4 °C (40 °F) or above during the placement of concrete. The temperature differential between the coldest or warmest surface and the fresh concrete shall not be more than 17 °C (30 °F).

(b) Cold Weather. Maintain concrete at a temperature of not less than 10 °C (50 °F) for the first 3 days and not less than 4 °C (40 °F) for the next 4 days. The count of time will commence immediately upon completion of final placement and vibration. One 24 hour period shall constitute 1 day.

The temperature of the concrete will be determined by placement of thermometers on the concrete surfaces and properly insulating said devices to record the surface temperature of the concrete according to Test Method No. Nev. T440. Temperature will be monitored continuously throughout the total protection time required by this Subsection. If the surface temperature of the concrete falls below the required temperatures specified above for a duration of 3 hours or more in any 24 hour period during the time of temperature protection, the time will be increased 1 day for each day this occurs. Maintain an absolute minimum temperature of 2 °C (35 °F) for the total time of protection specified. Should the temperature of the concrete fall below 2 °C (35 °F) at any time, damage may occur. The assessment of damage will be determined by the Department and concrete so damaged may require repair or replacement at the option of the Engineer.

Maintain the concrete temperature above 2 °C (35 °F) for at least 24 hours after wet curing of bridge decks and approach slabs.

Supply the concrete at a temperature of at least 10 °C (50 °F) and not more than 32 °C (90 °F) at the time of placing. See Subsection 501.03.06. Do not use heating equipment or methods which alter or prevent the entrainment of the required amount of air in the concrete. Use equipment capable of heating the materials uniformly. Do not heat aggregates and water used for mixing to a temperature exceeding 66 °C (150 °F). Do not use concrete containing frost or lumps at the time of placing.

Stockpiled aggregates may be heated by the use of dry heat or steam. Do not heat aggregates directly by gas or oil flame or on sheet metal over fire. Do not use live steam on or through binned aggregates.

Maintain reinforcing steel free of ice, snow, or frost during placement of concrete. Do not place concrete on frozen ground.

(c) Low Temperature Protection. After the concrete has been placed, take means to protect the concrete from impending low temperatures. Methods and materials not hereinafter prescribed may be used if approved and the materials are fire resistant, waterproof, and do not adhere, abraid, or damage the surface of the concrete.

Use fire resistant and waterproof insulating blankets to protect concrete from low temperatures. Secure the blankets and overlap along the edges and joints to insure that no opening will exist in the protection due to high winds or other adverse conditions. Make provisions to allow the reading of thermometers placed inside of the protection. When depositing concrete against previously cast concrete, extend the blanket insulation at least 350 mm (14 in.) onto the existing concrete and securely hold in place.

Concrete may be protected by applying artificial heat within an enclosure. Construct the enclosure with fire resistant material, unless otherwise approved. Arrange the heating system so as to provide uniform heating, insuring that the concrete farthest from the source of heat is receiving adequate protection without drying the concrete near the source of heat so as to cause shrinkage cracks. Do not use heaters that use combusted fuel or exhaust gas to directly heat the enclosure.

(d) Hot Weather. Supply concrete at a temperature of not more than 32 °C (90 °F) measured immediately before placement.

For continuous placement on the deck on continuous steel units, retard the initial set of the concrete sufficiently to insure that it remains plastic in not less than the span immediately preceding the one being placed.

For both simple and continuous spans, submit a retardation schedule for approval.

The consistency of the concrete as placed should allow the completion of initial finishing operations without the addition of water to the surface.

When conditions are such that additional moisture is needed for initial finishing, apply the required water to the surface by fog spray only, and hold to a minimum amount. Apply fog spray for this purpose as specified in Subsection 501.03.08.

From the time of initial strike-off until final finish is complete, protect the unformed surfaces of slab concrete from rapid evaporation of mixing water from the concrete due to wind, high temperature, low humidity, or combinations thereof.

Use fogging equipment capable of providing a fog mist, as necessary, to the area between the finishing machine and the tining machine. The fogging equipment shall meet the requirements of Subsection 501.03.08. If at any time it becomes apparent that the combination of fogging and curing application are not, or will not be effective in preventing plastic shrinkage cracking, stop the concrete placement until environmental conditions improve substantially, or until other preventative measures are approved in writing.

BASIS OF PAYMENT

**501.05.01 Payment.** Portland cement concrete will be measured and paid for by the provisions specified in the various Sections of these specifications covering construction requiring concrete.

# SECTION 502

## CONCRETE STRUCTURES

### DESCRIPTION

**502.01.01 General.** This work consists of furnishing and placing Portland cement concrete in bridges, approach slabs, culverts, headwalls, retaining walls, barrier rail, and other designated structures. This work also consists of furnishing and installing expansion joints and elastomeric bearing pads.

### MATERIALS

**502.02.01 General.** Material shall conform to the following Sections:

| | |
|---|---|
| Portland Cement Concrete | Section 501 |
| Concrete Curing Materials and Admixtures | Section 702 |
| Joint Material | Section 707 |
| Miscellaneous Metal | Section 712 |
| Reinforcement | Section 713 |
| Elastomeric Bearing Pads | Section 725 |

Use concrete of the class or classes designated in the proposal and on the plans. Unless otherwise specified, use Class A or Class AA concrete. Class D may be substituted for Class A concrete or Class DA may be substituted for Class AA concrete.

### CONSTRUCTION

**502.03.01 Depth of Footings.** Consider the elevation of the bottoms of footings, as shown on the plans, as approximate only and changes may be ordered in writing in dimensions or elevations of footings as may be necessary to secure a satisfactory foundation.

**502.03.02 Forms.** Build forms mortar tight and of sufficient rigidity to prevent distortion due to the pressure of the concrete and other loads incidental to the construction operations. Thoroughly clean forms previously used of all dirt, mortar, and foreign matter before being reused. Thoroughly coat all inside surfaces of the forms with an approved coating or form oil before concrete is poured in forms. Do not use coating or form oil which leaves film on the surface of the form that can be absorbed by the concrete. When required and immediately before placing concrete, thoroughly wet the forms with water.

Submit detailed plans of form work for examination when requested. If such plans are not satisfactory, make the necessary changes as required. Be responsible to obtain satisfactory results with the plans submitted or corrected.

Construct the forms to be substantial and unyielding and design so that the finished concrete will conform to the proper dimensions and contours. Design forms to take into account the effect of vibration on the concrete as it is placed.

Fillet forms at all exposed corners unless corners are rounded as hereinafter provided. Use triangular molding for fillets with 2 equal sides. In general, the width of the equal sides of moldings shall be 19 mm (3/4 in.); for massive work, such as heavy pier copings and columns, the width shall be 38 to 50 mm (1.5 to 2 in.). Top edges of walls may be filleted or rounded as hereinafter provided for curbs. Round top edges of curbs and slabs with an edging tool to a radius of 12.5 to 19 mm (1/2 to 3/4 in.).

When concrete is placed in excavation, provide forms for all vertical surfaces unless otherwise permitted. Provide ports in high, thin walls to permit thorough cleaning before placing concrete.

Do not place forms or falsework supports on recently constructed footings or pile caps until the concrete has attained 80% of the required 28 day strength.

If the forms develop any defects, such as bulging or sagging after the concrete has been poured, correct that portion of the work in a satisfactory manner.

During the erection and after the completion of the forms, protect them in such manner as to preclude shrinkage, warping, curling, and distortion.

Keep the falsework and forms supporting the bottom slab of the superstructure of box girder structures in place until bridge deck curing and prestressing and grouting operations have been completed. Remove forms for the webs of box girders before the deck slab is poured. Completely remove all interior forms in box girders, except those otherwise permitted to remain in place, and clear the inside of the box girder of all loose material and sweep clean.

Side forms for beams, girders, columns, railing, or other members of the structure wherein the forms do not resist dead load bending may be removed as specified in Subsection 502.03.12 (c).

Remove the side forms for arches, columns, and piers before the members of the structure which they support are poured or placed, so that the quality of the concrete may be inspected. Construct all such side forms so that they may be removed without disturbing other forms which resist direct load or bending stresses.

The condition of the forms will have a direct bearing upon the amount of finishing required.

Use full pieces of forms which extend from the bottom to the top of the wall or post.

Form curved surfaces to provide a smooth surface without visible breaks.

Construct the forms so that portions, where finishing is required, may be removed without disturbing portions of forms to remain.

Construct forms of sufficient strength to carry the dead mass of the concrete as a liquid without a deflection in excess of span length/120, and if such deflection occurs, it will be sufficient cause for rejection of the work.

Camber forms for girders and slabs in such amounts as may be required.

Use approved form clamps or bolts to fasten forms. Do not use ties consisting of twisted wire loops to hold forms in position during the placing of concrete.

Provide positive acting bolts or form clamps of sufficient strength and number to prevent spreading of the forms. Provide such types that can be entirely removed or cut back sufficiently to allow finishing of the concrete.

Use Exterior B-B Class I plywood conforming to the National Institute of Standards and Technology Product Standards, PS 1, Construction and Industrial Plywood for forming of concrete surfaces exposed to view. Furnish and place plywood form panels in 1,200 mm (4 ft) widths and in uniform lengths of not less than 2,400 mm (8 ft), except where the dimensions of the member formed are less. Where form panels are attached directly to the studding or joints, use panels not less than 15.9 mm (5/8 in.) thick. Form panels less than 15.9 mm (5/8 in.) thick, may be used with continuous backing of 25 mm (1 in.) nominal thickness surfaced material. Place form panels in a neat symmetrical approved pattern. Place the panel with the long dimension perpendicular to the studs.

Plywood for left-in-place forms in box girders may be of any grade and thickness that will satisfy the other requirements of this Subsection.

Fabricate metal forms to remain in place for concrete deck slabs from steel conforming to ASTM A653, Grade 275 (40) minimum, having a coating designation of Z500 (G165). Thickness and grade of form sheets and form supports shall be as designated on the shop drawings. Minimum thickness for form sheets shall be 0.75 mm (22 gage) and for form supports shall be 1.60 mm (16 gage).

The following criteria shall govern the design of permanent stay-in-place steel bridge deck forms.

Design the steel forms on the basis of dead load of form, reinforcement, plastic concrete, plus 2.5 kN/m$^2$ (50 lb/ft$^2$) for construction loads. The unit working stress in the steel sheet shall be not more than 72.5% of the specified minimum yield strength of the material furnished, and not more than 250 MPa (36,000 psi).

The mass of metal forms plus the mass of deck slab, including concrete in form corrugation, shall not exceed the load for the mass of the slab at plan thickness by more than 720 N/m$^2$ (15 lb/ft$^2$), unless otherwise shown on the plans.

The dead load deflection of metal forms due to mass of plastic concrete, deck steel reinforcement, and metal forms shall not exceed the following:

(a) For form design spans of 3 m (10 ft) or less, L/180 or 12.5 mm (0.5 in.), whichever is less.

(b) For form design spans greater than 3 m (10 ft), L/240 or 19 mm (0.75 in.), whichever is less.

The total dead load used to compute this deflection shall in no case be less than 5.7 kN/m$^2$ (120 lb/ft$^2$).

Do not field weld metal bridge deck forms to structural steel bridge elements.

Base the permissible form camber on the actual dead load condition. Do not use camber to compensate for deflection in excess of the foregoing limits.

The design span of the form sheets shall be the clear span of the form plus 50 mm (2 in.) measured parallel to the form flutes.

Compute physical design properties according to requirements of the AISI Specification for the Design of Cold Formed Steel Structural Members, latest edition.

Design and detail permanent steel bridge deck forms to provide the specified plan deck thickness measured from the top of form corrugation to top of deck. Maintain the reinforcement dimensions and minimum concrete cover shown on the plans for both layers of primary deck reinforcement within the concrete deck.

Do not consider permanent steel bridge deck forms as lateral bracing for compression flanges of supporting structural members.

Do not use permanent steel bridge deck forms in panels where longitudinal deck construction joints are located between stringers.

Submit calculations and fabrication shop and erection drawings according to Subsection 105.02. Such drawings shall be stamped and signed by an engineer who is registered as a Civil Engineer in the State of Nevada. Indicate in these plans, the grade of steel and the physical and section properties for all permanent steel bridge deck form sheets.

Install forms according to submitted and approved detailed fabrication and erection plans.

Do not allow form sheets to rest directly on the top of the stringer or floor beam flanges. Securely fasten sheets to form supports with a minimum bearing length of 25 mm (1 in.) at each end. Place form supports in direct contact with the flange of stringer or floor beam. Make all attachments to form supports by permissible welds, bolts, clips, or other approved means. Weld according to the provisions of AWS D1.1/D1.1M, except that 3 mm (0.125 in.) fillet welds will be permitted.

Thoroughly clean, wire brush, and paint satisfactorily any permanently exposed form metal where the galvanized coating has been damaged with 2 coats of zinc oxide-zinc dust primer, FSS TT-P-641, Type II, no color added. Minor heat discoloration in areas of welds need not be touched up.

Locate transverse construction joints at the bottom of a flute and field drill 6 mm (0.25 in.) weep holes not more than 300 mm (12 in.) on center along the line of the joint.

Place particular emphasis on proper vibration of the concrete to avoid honeycomb and voids, especially at construction joints, expansion joints, valleys, and ends of form sheets. Use approved pouring sequences, procedures, and mixes. Do not use calcium chloride or any other admixture containing chloride salts in concrete placed on permanent steel bridge deck forms.

After the deck concrete has been in place for a minimum period of 2 days, test the concrete for soundness and bonding of the forms by sounding with a hammer as directed. If areas of doubtful soundness are disclosed by this procedure, remove the forms from such areas for visual inspection after the pour has attained adequate strength.

At locations where sections of the forms are removed, the replacement of the forms will not be required, but repair the adjacent metal forms and supports to present a neat appearance and assure their satisfactory retention. As soon as the form is removed, the concrete surfaces will be examined for cavities, honeycombing, and other defects. If irregularities are found, and it is determined that these irregularities do not justify rejection of the work, repair the concrete as directed and give it an ordinary surface finish. If the concrete where the form is removed is unsatisfactory, remove additional forms, as necessary, to inspect and repair the slab. Modify methods of construction as required to obtain satisfactory concrete in the slab. Remove and repair all unsatisfactory concrete as directed.

The amount of sounding and form removal may be moderated, at the Engineer's discretion, after a substantial amount of slab has been constructed and inspected, if the results of the inspections indicate that sound concrete is being obtained throughout the slabs.

**502.03.03 Falsework.** Design and construct safe and adequate falsework which provides the necessary rigidity, supports the loads imposed, and produces the finished structure lines and grades indicated on the plans.

Furnish detailed drawings of falsework, along with design calculations showing the stresses and deflections of the load supporting members, according to Subsection 105.02, for any structure having a clear cast-in-place span of 6 m (20 ft) or greater, or where any falsework clear span length exceeds 5 m (16 ft), or where provisions for vehicular, pedestrian, or railroad traffic through the falsework is made. Include a diagram showing concrete placement sequence with construction joint locations, and details of the methods, sequences and equipment proposed for falsework removal. Such drawings and calculations shall be stamped with a seal and signed by an engineer who is registered as a Civil Engineer in the State of Nevada. Joists and form work for pier caps, deck slabs, and deck overhangs shall be considered as falsework and shall be designed as such and submitted for approval according to this Subsection. If such drawings are not satisfactory, have such changes made in them as may be required.

Show anticipated total settlement of falsework in the drawings. Total settlement should include falsework footing settlement and joint take up. Anticipated settlements shall not exceed 25 mm (1 in.). For girder bridges, design falsework supporting deck slabs and overhangs with no differential settlement between the girders and the deck forms during placement of deck concrete.

Submit a falsework and formwork removal plan as part of the falsework submittal if falsework and formwork is proposed to be supported or suspended from the structure during removal. Include the following information:

1. The location and size of any access holes along with details and product information addressing how the holes will be repaired.
2. The location, capacity, and size of any attachments, beams, cables, and other hardware used to attach to the structure or support the falsework and formwork.
3. The type, capacity and factor of safety, weight, and spacing of points of reaction of lowering equipment.
4. Substantiating calculations for configuration and operation of the lowering system.
5. The weight at each support point of the falsework and formwork being lowered.
6. Calculations demonstrating that affected portions of the structure are not adversely impacted.

Approval by the Engineer of the falsework drawings or falsework inspection performed by the Engineer will in no way relieve the Contractor of full responsibility for the falsework.

Falsework on steel structures shall also conform to Subsection 506.03.23.

Do not use earth fills in lieu of falsework unless otherwise indicated on the plans or approved in writing.

Use earth fill materials and construct earth fills according to the requirements for borrow embankment in Section 203. Do not use fill slopes greater than the angle of repose for the material being used. Place a minimum berm of 1 m (3 ft) around the structure at the top of the fill.

For bridges with seat type abutments, the abutment stem wall cannot be used to retain the soffit fill material unless an equivalent height of fill is placed behind the abutment.

Construct a concrete waste slab of 100 mm (4 in.) minimum thickness at the interface of the earth fill and structure soffit. Concrete shall be Class A or Class AA concrete as directed.

Furnish detailed drawings of earth fill embankment according to Subsection 105.02 including the following information:

1. Plan and section (transverse and longitudinal) views of the proposed earth fill.
2. Verification that the limits of the earth fill is within the project constraints (available right of way, maintenance of traffic, etc.) and measures to retain earth fills.
3. Settlement calculations for the proposed earth fill and the in-situ soil demonstrating the total maximum anticipated settlement will not exceed 25 mm (1 in.).
4. Measures for grading the concrete waste slab to provide proper superstructure geometry and camber.

5. Method of isolating substructure elements to permit unrestrained deflections due to structure post-tensioning.
6. Provisions for protection of the post-tensioning hardware, specifically the low-point vents, to ensure that they remain intact during post-tensioning and grouting operations.
7. Description of earth fill removal procedures demonstrating conformance with Subsection 502.03.12.

Except for placement of foundation pads, do not start the construction of any unit of falsework until the drawings for that unit are reviewed and approved.

When footing type foundations are used, determine the bearing resistance and estimated settlement of the soil and show the determined values for both wet and dry soil conditions in the falsework design calculations. Design footings to support anticipated falsework loads without exceeding the estimated soil bearing resistance and anticipated settlements.

When pile supported foundations are used, determine the characteristics of the site soils and design piling to support anticipated falsework loads. Determine the bearing resistance and estimated settlement of the piling system and ensure the falsework design does not exceed these values. Remove piling to an approved final condition and in an approved manner that will not adversely impact the finished structure.

Design foundations for heavy-duty steel shoring or steel pipe column falsework so that uniform settlement takes place under all legs of each tower under all loading conditions.

Make provisions for drainage of any excavation in the vicinity of the abutment and pier footings to prevent the ponding of water which could cause degradation of the foundation material.

The design load for falsework shall consist of the sum of dead and live vertical loads, and an assumed horizontal load. The minimum total design load for any falsework shall be not less than 4.8 kN/m$^2$ (100 lb/ft$^2$) for the combined live and dead loads regardless of slab thickness.

Dead loads shall include the mass of concrete, reinforcing steel, and forms. The weight of concrete, reinforcing steel, and forms shall be assumed to be not less than 26 kN/m$^3$ (160 lb/ft$^3$) for normal concrete and not less than 20 kN/m$^3$ (130 lb/ft$^3$) for lightweight concrete.

Live loads shall consist of the actual load of any equipment to be supported by falsework applied as concentrated loads at the points of contact and a uniform load of not less than 960 N/m$^2$ (20 lb/ft$^2$) applied over the area supported. In addition to the preceding live loads, assume a load of 1,100 N/m (75 lb/ft) applied to the outside edge of deck overhangs.

The assumed horizontal load to be resisted by the falsework bracing system shall be the sum of the actual horizontal loads due to equipment, construction sequence, or other causes. In no case shall the assumed horizontal load to be resisted in any direction be less than 2% of the total dead load. Design the falsework so that it will have sufficient rigidity to resist the assumed horizontal load before the placement of concrete.

The minimum horizontal design wind load allowed for heavy-duty steel shoring or steel pipe column falsework having a vertical load carrying capacity exceeding 130 kN (30 kips) per leg or column shall be the sum of the products of the wind impact area, shape factor, and applicable wind pressure value for each height zone. Consider the wind impact area as the total projected area of all elements in the tower face or falsework bent normal to the direction of the applied wind. Use a shape factor of 2.2 for heavy-duty shoring and 1.0 for pipe column falsework. Refer to the current AASHTO “Guide Design Specifications for Bridge Temporary Works” for wind loading design.

The minimum horizontal design wind load allowed on all other types of falsework, including falsework supported on heavy-duty shoring or pipe column falsework, shall be the sum of the products of the wind impact area and applicable wind pressure value for each height zone. Consider the impact area as the gross projected area of the falsework and any unrestrained portion of the permanent structure, excluding the areas between falsework bents or towers where diagonal bracing is not used. Refer to the current AASHTO “Guide Design Specifications for Bridge Temporary Works” for wind loading design.

Design falsework for the support of superstructures assuming the entire superstructure cross-section, except railing, is to be placed at one time.

In addition to the minimum requirements specified in Subsection 502.03.03, when designing falsework for box girder structures with internal falsework bracing systems using flexible members capable of withstanding tensile

forces only, include in the design, the vertical effects caused by the horizontal load combined with the dead and live loads imposed by concrete placement for the girder stems and connected bottom slabs.

Provide temporary bracing, as necessary, to withstand all imposed loads during erection, construction and removal of any falsework. Show provisions in the falsework drawings for temporary bracing or other acceptable methods during each phase of erection and removal. Design the temporary bracing to resist wind loads.

If the concrete is to be prestressed, design the falsework to support any increased or readjusted loads caused by prestressing forces.

Use the following maximum allowable stresses, loadings, and deflections in the design of the falsework. The stresses listed are based upon the use of undamaged, high quality materials. Reduce such stresses if lesser quality materials are to be used. Properly evaluate falsework materials and design the falsework to safely carry the actual loads imposed.

(a) Timber.

| | |
|---|---|
| Compression perpendicular to the grain | 3.1 MPa (450 psi) |
| Compression parallel to the grain, subject to column action correction | 11.0 MPa (1,600 psi) |
| Extreme fiber stress in bending | 12.4 MPa (1,800 psi) |
| Horizontal shear | 1.0 MPa (140 psi) |
| Axial tension | 8.3 MPa (1,200 psi) |
| Modulus of elasticity | 11.0 GPa (1.6 x $10^6$ psi) |

(b) Structural Glued Laminated Timbers About x-x Axis.

| | |
|---|---|
| Compression perpendicular to the grain | 3.5 MPa (500 psi) |
| Compression parallel to the grain, subject to column action correction | 11.0 MPa (1,600 psi) |
| Extreme fiber stress in bending | 13.8 MPa (2,000 psi) |
| Horizontal Shear | 1.3 MPa (185 psi) |
| Modulus of elasticity | 11.7 GPa (1.7 x $10^6$ psi) |

(c) Plywood and Plyform.

| | |
|---|---|
| Compression perpendicular to face | 2.9 MPa (425 psi) |
| Extreme fiber stress in bending | 13.8 MPa (2,000 psi) |
| Rolling shear | 0.8 MPa (110 psi) |
| Shear perpendicular to the plies | 1.7 MPa (250 psi) |
| Modulus of elasticity | 11.0 GPa (1.6 x $10^6$ psi) |

Design timber connections according to the stresses and loads allowed in the National Design Specifications for Wood Construction by the National Forest Products Association except do not apply the reductions in allowable loads required therein for high moisture condition of the lumber and service conditions.

(d) Steel. For identified grades of steel, do not exceed design stresses, except stresses due to flexural compression, by more than 125% of those specified in the Manual of Steel Construction as published by the AISC.

When the grade of steel cannot be positively identified, do not exceed design stresses, except stresses due to flexural compression, of either those specified in said AISC Manual for ASTM A36 (AASHTO M183) steel or the following:

| | |
|---|---|
| Tension, axial and flexural | 152 MPa (22,000 psi) |
| Compression, axial except L/r shall not exceed 120 | 110 –0.0026$(L/r)^2$ MPa [16,000 –0.38$(L/r)^2$ psi] |
| Shear on gross section of web | 100 MPa (14,500 psi) |
| Web crippling for rolled shapes | 110 MPa (16,000 psi) |

For all grades of steel, do not exceed the following design stresses:

Compression, flexural ..... $\frac{82{,}700}{Ld/bt}$ MPa $\left[\frac{(12 \times 10^6)}{Ld/bt}\right]$ psi

but not to exceed 152 MPa (22,000 psi) for unidentified steel or steel conforming to ASTM A36 nor 125% of 0.6 Fy for other identified steel.

In the foregoing formulas, “L” is the unsupported length; “d” is the least dimension of rectangular columns, or the width of a square of equivalent cross-sectional area for round columns, or the depth of beams; “b” is the width; “t” is the thickness of the compression flange; and “r” is the radius of gyration of the member. All dimensions are expressed in mm (in.). “Fy” is the specified minimum yield stress, MPa (psi), for the grade of steel used.

The modulus of elasticity (E) used for steel shall be 200 GPa (29.0 x $10^6$ psi).

(e) Deflections. Do not consider live and impact loads in calculating deflections.

For plywood, joists, and those other members where it is not practical to provide risers or camber strips, the limiting deflection shall not be greater than 1/270 of the span.

For stringers, girders, and other load carrying members paralleling the roadway centerline where span deflection of 5 mm (0.2 in.) or more is anticipated, install risers to provide for the calculated construction dead load deflection in addition to the camber requirements as set forth in the plans. Deflection of these load carrying members will not be a limiting factor where risers are provided. Stress, in this case, is the control.

(f) Manufactured Assemblies. Do not exceed the manufacturer's recommendations for the maximum loadings and deflections used on jacks, brackets, columns, joists, and other manufactured devices. Do not exceed 1/270 of the spans for dead load deflection of such joists used at locations other than under deck slabs between girders. If requested, furnish catalog data listing such manufacturer's recommendations or perform tests as necessary to demonstrate the adequacy of any such device proposed for use.

(g) Special Locations. In addition to the minimum requirements specified in this Subsection, the design and construction of falsework over or adjacent to roadways or railroads which are open to traffic shall be stable if subject to impact by vehicles. Consider falsework posts which are supporting members that cross over a roadway or railroad as being adjacent to roadways or railroads. Consider falsework posts adjacent to roadways if the row of posts nearest the roadway is located within a horizontal distance less than or equal to the combined total height of the falsework and forms. Consider falsework posts adjacent to railroads if the row of posts nearest the tracks are within a horizontal distance less than 3 m (10 ft) measured from the centerline of the tracks. Provide any additional features for the work needed to ensure that falsework will be stable if subjected to impact by vehicles. The falsework design at these locations shall include, but not be limited to, the following minimum provisions specified herein.

The vertical load used for the design of falsework posts and towers, but not footings, which support the portion of the falsework over openings, shall be the greater of the following:

1. 150% of the design load calculated in conformance with the provisions for design load previously specified but not including any increased or readjusted loads caused by the prestressing forces, or

2. The increased or readjusted loads caused by the prestressing forces.

Falsework posts adjacent to roadways or railroads shall consist of either steel with a minimum section modulus about each axis of 156 x $10^3$ $mm^3$ (9.5 $in.^3$) or sound timbers with minimum section modulus about each axis of 4.1 x $10^6$ $mm^3$ (250 $in.^3$).

Mechanically connect each falsework post adjacent to roadways or railroads to its supporting footing at its base, or otherwise provide lateral restraint, so as to withstand a force of not less than 9 kN (2,000 lb) applied at the base of the post in any direction except toward the roadway or railroad track. Also, mechanically connect posts to the falsework cap or stringer capable of resisting a load in any horizontal direction of not less than 4.5 kN (1,000 lb).

For falsework spans over roadways, mechanically connect to the falsework cap or framing, all exterior falsework stringers and stringers adjacent to the ends of discontinuous caps, the stringer or stringers over points of minimum vertical clearance and every fifth remaining stringer. The mechanical connections shall be capable of resisting a load in any direction, including uplift on the stringer, of not less than 2.2 kN (500 lb). Install connections before traffic is allowed to pass beneath the span. Connect all falsework stringers to the caps for falsework spans over railroads.

Connect timber bracing to falsework bents which are located adjacent to roadways and railroads with 16 mm (5/8 in.) diameter or larger bolts.

Construct the falsework to conform to the falsework drawings. Use materials of the quality necessary to sustain the stresses required by the falsework design. Construct falsework that will support the loads imposed on it without excessive settlement or take-up beyond that shown on the falsework drawings. Use suitable screw jacks or wedges in pairs in connection with the falsework to set the forms to grade or camber as shown on the plans, or to take up any

settlement in the form work either before or during the placing of concrete. Excessive use of blocking and shims will be cause for rejection of the falsework.

Upon completion of the falsework and before placing loads, the Civil Engineer responsible for the above falsework design shall perform an on-site inspection and certify to the Engineer that each falsework system has been assembled according to the approved falsework drawings and that the quality of the materials used is consistent with the falsework design. In the event that multiple Civil Engineers have developed the falsework design, each Civil Engineer shall perform an on-site inspection and provide a certification for their responsible portion. Use of videotaping or other media to inspect falsework will not be allowed. Correct all identified deficiencies in the falsework. Do not place loads on the falsework until the Engineer has received the certifications.

Immediately before placing bridge superstructure concrete, check all falsework and wedges or jacks and make all necessary adjustments. Exercise care to insure that settlement and deflection due to the added mass of the superstructure concrete will be a minimum. Provide suitable means such as telltales attached to the soffit forms to permit ready measurement of settlement and deflection as it occurs.

Should unanticipated events occur, including settlements that deviate more than ± 10 mm (3/8 in.) from those indicated on the falsework drawings, which in the opinion of the Engineer would prevent obtaining a structure conforming to the requirements of these specifications, discontinue placement of concrete until corrective measures satisfactory to the Engineer are provided. In the event satisfactory measures are not provided prior to initial set of the concrete in the affected area, discontinue placement of concrete at a location determined by the Engineer, and remove all concrete in the affected area.

Place falsework on a solid footing safe against undermining, protected from softening, and capable of supporting the loads imposed on it. When requested, demonstrate by suitable load tests that the soil bearing values assumed for the design of the falsework do not exceed the supporting capacity of the soil.

Provide falsework openings for traffic and pedestrians as shown in the plans. Firmly attach solid sheeting of 19 mm (3/4 in.) plywood or 50 mm (2 in.) planking to the vertical supports adjacent to the travelway. Extend the sheeting vertically from 450 mm (18 in.) above the roadway surface to 2.25 m (7.5 ft) above the roadway surface. Place portable temporary barrier rail, along each edge of the travelway. Install barrier rail a minimum of 300 mm (1 ft) from the vertical supports of the falsework.

Provide falsework openings for railroad traffic as shown on the plans. Completely sheath falsework bents located within 6 m (20 ft) of the center line of a railroad track in the area between 1 m (3 ft) and 5 m (17 ft) above the track elevation on the side facing the track. Sheathing shall consist of plywood not less than 16 mm (5/8 in.) thick or lumber not less than 19 mm (3/4 in.) thick. In addition to sheathing, provide bracing on the bents to resist the design horizontal load or 22 kN (5,000 lb) whichever is greater.

**502.03.04 Reinforcement.** Furnish and place reinforcing as shown on the plans and according to Section 505.

**502.03.05 Cofferdams and Cribs.** Carry cofferdams for foundation construction well below the bottom of the footings and adequately brace and make as watertight as practical. Make the interior dimensions of cofferdams such as to provide sufficient clearance for constructing forms and, when no seal is placed, to permit pumping outside the forms.

Submit for approval, drawings and design calculations showing proposed method of construction of cofferdams or cribs according to Subsection 105.02. Such drawings and calculations shall be stamped with a seal and signed by an engineer who is registered as a Civil Engineer in the State of Nevada. Do not start cofferdam construction before the submitted drawings are approved.

After the completion of the substructure, remove the cofferdams with all sheeting and bracing to 300 mm (1 ft) below the stream bed. Perform such removal in such a manner as not to disturb or mar the finished concrete foundation.

**502.03.06 Pumping Water.** Perform pumping from the interior of any foundation enclosure in such a manner as to preclude the possibility of the movement of water through any fresh concrete. Do not pump during the placing of concrete or for a period of at least 24 hours thereafter, unless it is done from a suitable pump separated from the concrete work by a watertight wall or other effective means.

Do not pump to dewater a sealed cofferdam until the seal has set sufficiently to withstand the hydrostatic pressure.

**502.03.07 Mixing Concrete.** Mix and proportion concrete as specified in Section 501.

**502.03.08 Handling, Placing, and Curing Concrete.** (a) General. In preparation for the placing of concrete, remove all sawdust, chips, and other construction debris and extraneous matter from the interior of forms. Remove temporary struts, stays, and braces, which hold the forms in correct shape and alignment, pending the placing of concrete, when the concrete placing has reached an elevation rendering their service unnecessary. Entirely remove these temporary members from the forms and do not bury in the concrete.

Verify the installation of all embedded items shown on the plans prior to concrete placement. Do not post install items shown as embedded unless the plans indicate post installation.

Before placement of major concrete, the Engineer may designate a time and place satisfactory to the Contractor for a pre-pour conference. The pre-pour conference shall be held not more than 2 weeks in advance of the scheduled pour. At such time, requirements will be outlined to be followed in the performance of the work.

Do not use concrete which does not reach its final position in the forms within the time stipulated under Section 501.

Thoroughly moisten surfaces on which concrete is to be placed with water immediately before placing concrete.

Place concrete to avoid segregation of the material and displacement of the reinforcement. The use of long troughs, chutes, and pipes for conveying concrete from the mixer to the forms may be permitted only with written approval. If inferior concrete is produced by the use of such conveyors, their use will be ordered discontinued and a satisfactory method of placing substituted.

Make open troughs and chutes of metal or line with metal. On steep slopes, equip the chutes with baffles or use with short lengths that reverse the direction of movement.

Keep all chutes, troughs, and pipes clean and free from coatings of hardened concrete by thoroughly flushing with water after each run. Discharge water used for flushing clear of the structure.

When placing operations would involve dropping the concrete more than 1.2 m (4 ft), deposit it through steel or other approved pipes. Keep the pipe full of concrete during placing and do not exceed a drop height of 0.3 m (1 ft) from the end of pipe to the surface of the newly placed concrete unless approved. After initial set of the concrete, do not jar the forms or place strain on the ends of projecting reinforcement bars.

Consolidate concrete placed in concrete structures, except tremie seal concrete, by means of mechanical vibration subject to the following paragraphs:

1. Supply enough vibrators to consolidate incoming concrete to a proper degree within 15 minutes after it is deposited in the forms. Make available at least 2 vibrators at the site of the structures where more than 20 $m^3$ (25 $yd^3$) of concrete is being placed.

2. Internally vibrate unless given special authorization for other methods.

3. Use vibrators capable of transmitting vibration to the concrete at frequencies of not less than 4,500 impulses per minute.

4. Use an intensity of vibration such as to visibly affect a mass of concrete of 25 mm (1 in.) slump over a radius of at least 450 mm (18 in.).

5. Manipulate vibrators to thoroughly work the concrete around the reinforcement, imbedded fixtures, and into the corners and angles of the forms.

   Apply vibration at the point of deposit and in the area of freshly deposited concrete. Insert and withdraw the vibrators out of the concrete slowly. Vibrate for sufficient duration and intensity to thoroughly consolidate the concrete, but do not continue at any one point to the extent that localized areas of grout are formed.

   Uniformly space vibrators not farther apart than twice the radius over which the vibration is visibly effective.

6. Do not apply vibration directly or through the reinforcement to sections or layers of concrete which have hardened to the degree that the concrete ceases to be plastic under vibration. Do not use to make concrete

flow in the forms over distances so great as to cause segregation, and do not use vibrators to transport concrete in the forms.

7. Supplement vibration by such spading as necessary to insure smooth surfaces and dense concrete along form surfaces and in corners and locations impossible to reach with the vibrators.

8. Apply the provisions of this article to the filler concrete for steel grid floor, except apply the vibrator to the steel.

9. Provide vibrators used to consolidate concrete containing epoxy-coated reinforcing steel with a resilient covering to prevent damage to the coating.

Immediately following the discontinuance of concrete placement, remove all accumulations of mortar splashed upon the reinforcement and the surfaces of forms. Do not puddle dried mortar chips and dust into the unset concrete. If the accumulations are not removed before the concrete sets, exercise care not to injure or break the concrete-steel bond at and near the surface of the concrete while cleaning the reinforcement.

(b) Culverts. Place the base slab or footings of box culverts and allow to set before the remainder of the culvert is constructed.

Before concrete is placed in the sidewalls, thoroughly clean the culvert footing of all shavings, sticks, sawdust, or other extraneous material and carefully chip and roughen the surface to a minimum 6 mm (1/4 in.) amplitude.

Do not construct walls and top slab monolithically on box culverts where the depth of pour below the bottom of the top slab exceeds 1.2 m (4 ft) unless approved in writing. Make any necessary construction joints vertical and at right angles to the axis of the culvert.

When walls are placed separately, in rigid frames or box culverts, place the concrete in the walls and allow to set a minimum of 12 hours before placing the top slab.

Construct each wing wall, monolithically. When necessary, make construction joints horizontal and locate so that no joint will be visible in the exposed face of the wing wall above the ground line.

(c) Girders, Slabs, and Columns. When the height of any point of web is more than 0.9 m (3 ft) from the bottom of the top slab to bottom of the web for “T” beams, or to construction joint for box girders, place the webs independent of the soffit and the top slab independent of the webs.

Place concrete in slab spans in one continuous operation for each span unless otherwise specified.

Place concrete in columns in one continuous operation, unless otherwise specified. Allow the concrete to set at least 12 hours before the succeeding pour is started.

Before placing concrete for superstructure, remove the forms of columns sufficiently to determine the character of the concrete in the columns.

Cure formed concrete according to Subsection 501.03.08.

**502.03.09 Pumping Concrete.** Arrange the equipment so that no vibrations result which might damage freshly placed concrete.

Where concrete is conveyed and placed by mechanically applied pressure, supply suitable equipment and adequate in capacity for the work. Operate pump so that a continuous stream of concrete without air pockets is produced. When pumping is completed, eject the concrete remaining in the pipeline, if it is to be used, in such a manner that there will be no contamination of the concrete or separation of the ingredients.

Do not use aluminum conduit for concrete pumping.

**502.03.10 Concrete Deposited Under Water.** If conditions render it impossible or inadvisable, in the opinion of the Engineer, to dewater excavations before placing concrete, deposit under water, by means of a tremie or a concrete pump, a seal course of concrete of sufficient thickness to thoroughly seal the cofferdam. Carefully place the concrete in a compact mass and do not disturb after being deposited. Maintain still water at the point of deposit.

Do not use an aluminum tremie for placing concrete.

A tremie shall consist of a watertight tube having a diameter of not less than 250 mm (10 in.) with a hopper at the top. When a batch is dumped into the hopper, induce the flow of concrete by slightly raising the discharge end, always keeping it in the deposited concrete.

Equip concrete pump discharge tubes and tremie tubes with a device that will prevent water from entering the tube while charging the tube with concrete. Support such tubes so as to permit free movement of the discharge end over the entire top surface of the work and to permit rapid lowering when necessary to retard or stop the flow of concrete. Fill the tubes by a method that will prevent washing of the concrete. Completely submerge the discharge end in concrete at all times. The tubes shall contain sufficient concrete to prevent any water entry. Provide continuous flow until the work is completed and the resulting concrete seal is monolithic and homogeneous.

Concrete deposited in water shall be Class A or Class AA with 10% extra cement added. The exact thickness of the seal will depend upon the hydrostatic head, bond and spacing of piles, size of cofferdam, and other related factors, but provide a seal not less than 600 mm (2 ft) in thickness. Before dewatering, allow the concrete in the seal to cure for not less than 5 days after placing.

If a seal which is to withstand hydrostatic pressure is placed in water having a temperature below 7 °C (45 °F), increase the curing time before dewatering. Do not consider periods of time during which the temperature of the water has been continuously below 3 °C (38 °F) as curing time. After the concrete seal obtains adequate strength, dewater the cofferdam and clean the top of the concrete of all scum, laitance, and sediment. Before fresh concrete is deposited, remove local high spots as necessary to provide proper clearance for reinforcing steel.

**502.03.11 Construction Joints.** Make construction joints only where located on the plans or shown in the pouring schedule, unless otherwise approved.

Concrete construction joints designated as “construction joint” on the plans are mandatory and shall be incorporated into the work unless otherwise approved in writing.

Do not place holes or blockouts in deck slabs unless otherwise shown on the plans or as approved in writing.

Where the placing of concrete is delayed until the placed concrete has taken its initial set and for which no expansion joints are provided, plan for in advance and receive approval for construction joints. Place concrete continuously from joint to joint. Make these joints perpendicular to the principal lines of stress and, in general, locate at points of minimum shear. Make joints only as shown on the plans in cantilevered members. Avoid horizontal joints at piers and abutments, except where specified, and when used do not locate within 600 mm (2 ft) of the normal water level.

Unless otherwise specified, strike off construction joints but do not trowel.

When making a horizontal construction joint, take care to have the concrete as dry as possible, and draw off any excess water or creamy material before the concrete sets. On all exposed surfaces, make the line of the proposed joint truly straight by placing a temporary straightedge on the inside of the form and pouring the concrete so that it will set flush with the edge as provided.

Avoid visible joints upon exposed faces, smooth the top surfaces of the concrete adjacent to the forms with a trowel. Where a “feather edge” might be produced at a construction joint, as in the sloped top surface of a wing wall, use a form work insert to produce a blocked out portion in the preceding layer which produces an edge thickness of not less than 150 mm (6 in.) in the succeeding layer.

When the work is unexpectedly interrupted by breakdowns, inclement weather, or other causes, and the concrete as placed would produce an improper construction joint, either rearrange the freshly deposited concrete, or continue by hand mixing, if necessary, until a suitable arrangement is made for a construction joint. When such a joint occurs at a section on which there is shearing stress, provide adequate mechanical bond across the joint by inserting reinforcing steel, or by some other satisfactory means, which will prevent a plane of weakness.

In resuming work, thoroughly clean the surface of the concrete previously placed of dirt, scum, laitance, or other soft or porous materials by one of the following methods:

(a) Clean concrete surface of fresh concrete (not more than 8 hours after placement) with air and water jets in such a manner that the surface is thoroughly cleaned and the aggregate is not loosened.

(b) Clean hardened concrete surface (more than 8 hours after placement) by abrasive blast methods in such a manner that the aggregate is not loosened or the edges of the concrete shattered.

Thoroughly wash the surface of the joint with clean water and tighten the forms to close contact with the previously placed work. Wet the surface of the joint just before placing new concrete.

Prior to deck grooving, seal construction joints in decks and approach slabs including an area extending 150 mm (6 in.) on each side of the joint with crack sealant according to Section 646.

**502.03.12 Removal of Falsework and Forms.** (a) General. Do not use a method of form removal likely to cause overstressing of the concrete. Do not remove forms and their supports without approval. Remove supports in such a manner as to permit the concrete to uniformly and gradually take the stresses due to its own mass and such that supports not yet removed remain stable at all times.

Compressive strengths will be determined by Test Methods No. Nev. T428 and ASTM C39 and will be considered information tests only and not acceptance tests as described in Subsection 501.02.05.

The time and strength requirements placed on falsework removal also pertains to the removal of earth fills used in lieu of falsework. Retain the slopes of the earth fill as originally placed until the same time and strength requirements are met.

(b) Falsework. Do not release falsework supporting any span of a simple span bridge before 10 days after the last concrete, excluding concrete above the bridge deck, has been placed. Do not release falsework supporting any span of a continuous or rigid frame bridge before 10 days after the last concrete, excluding concrete above the bridge deck, has been placed in that span and in the adjacent portions of each adjoining span for a length equal to at least half the length of the span where falsework is to be released.

Do not release falsework for bridge spans until the last concrete has attained a compressive strength of 80% of the specified strength.

In cold weather, increase all time requirements one day for every day the curing time is increased as prescribed in Subsection 501.03.09 (b).

Do not release falsework for cast-in-place prestressed portions of structures until at least 24 hours after all the prestressing steel has been tensioned and grouted.

Do not remove falsework supporting any span of a continuous or rigid frame bridge until all required prestressing has been completed in that span and in the adjacent portions of each adjoining span for a length equal to at least half the length of the span where falsework is to be released.

Remove falsework for arch bridges uniformly and gradually, beginning at the crown and working toward the springing, to permit the arch to take its load slowly and evenly. Strike falsework for adjacent arch spans simultaneously.

Do not release falsework supporting overhangs, deck slabs between girders, and girder stems which slope 30° or more off vertical before 7 days after the deck concrete has been placed.

Falsework supporting the sides of the girder stems which slope less than 30° off vertical may be removed before placing deck slab concrete, providing a reshoring system is installed. The reshoring system consists of lateral supports which are designed to resist all rotational forces acting on the stem, including those caused by the placement of deck slab concrete. Install such lateral supports immediately after each form panel is removed and before the release of supports for the adjacent form panel.

Do not release falsework for bent caps which will support steel or precast concrete girders before 7 days after the cap concrete has been placed. Do not erect girders onto bent caps or abutments until all associated falsework has been released and the concrete in the cap or abutment has attained a compressive strength of 80% of the specified strength.

Do not release falsework for box culverts and other structures with decks lower than the roadway pavement and with span lengths of 4.2 m (14 ft) or less until the last placed concrete has attained a compressive strength of 11 MPa (1,600 psi), provided that curing of the concrete is not interrupted. Perform falsework removal for other box culverts in conformance to the requirements for release of bridge falsework.

Remove all falsework materials at least 0.6 m (2 ft) below the surface of the original ground or original stream bed. When falsework piling is driven within the limits of ditch or channel excavation areas, remove the falsework piling within such areas to at least 0.6 m (2 ft) below the bottom and side slopes of said excavated areas.

Remove all debris and refuse resulting from the work and leave the premises in a neat and presentable condition.

(c) Forms. Do not remove forms on parapets and curbs until concrete has set sufficiently to prevent distorting or cracking.

Do not remove forms for columns, walls, sides of beams, girders, and all other parts, which are not subjected to stress, until the concrete has reached a minimum age of 12 hours.

Do not remove forms which are subjected to stresses until the requirements of (b) above have been satisfied, unless otherwise approved.

Do not remove forms and replace with shoring, except as provided in (b) above.

**502.03.13 Expansion Joints and Waterstops.** Construct expansion joints and install waterstops according to the details shown on the plans, as specified herein, and as recommended by the manufacturer.

Construct bridge expansion joints to the tolerances specified for bridge decks in Subsection 502.03.16.

Place joint openings in the locations shown on the plans and construct by the insertion and subsequent removal of appropriate forming material. Accomplish the insertion and removal of the forming materials without chipping or breaking the corners of the concrete.

Insure that joint blockouts are free of curing compound, loose material, dirt, dust, grease, oil or other foreign matter at the time the joint material is placed.

After installation, flood joints with water and inspect for leakage. If leakage is observed, repair the joint as recommended by the manufacturer and as directed.

(a) Strip Seal Expansion Joints. Manufacturers of strip seal expansion joints are listed in the QPL.

Submit shop drawings according to Subsection 105.02 showing all material specifications, details and dimensions necessary to fabricate and install the strip seal expansion joints. For joint rehabilitation applications, measure actual joint widths and openings and show on the drawings.

Make the opening at expansion joints as designated on the plans for the temperature at time of installation. Employ positive methods in placing and securing the joints to keep them in correct position during concrete placement.

Do not place extrusions until after all deck and slab profile correction grinding is completed.

The steel extrusions can be supplied in minimum lengths of 6 m (20 ft) and field welded unless shown otherwise on the plans. All shop and field welding shall conform to Section 506. The extrusions shall conform to AASHTO M270. The extrusions shall be galvanized after fabrication unless steel is Grade 345W (50W).

Manufacture the strip seal gland as one continuous piece. Special intersections shall be shop fabricated in a mold under heat and pressure. Install the strip seal gland in one continuous length.

Lubricant adhesive used in bonding the gland to the steel restrainers shall be a one part moisture curing polyurethane and hydrocarbon solvent mixture conforming to ASTM D4070.

(b) Preformed Joint Fillers. Manufacturers of preformed joint fillers are listed in the QPL.

Provide materials meeting the anticipated joint opening and movement rating specified for each location. Submit product information according to Subsection 105.02 for each joint before ordering. Product information shall consist of all material specifications including allowable movement ratings, details, and dimensions necessary to install the preformed joint filler. For joint rehabilitation applications, measure actual joint openings and include with the submittal.

Form or saw cut the concrete joint opening to the specified width and depth shown on the plans for placement of the preformed joint filler. Form or saw cut the joint with a tolerance of plus zero and minus 3 mm (1/8 in.) between joint faces. Air blast joint surfaces with abrasive and thoroughly clean the open joint with compressed air.

Keep the joint clean and free of loose material, dirt, dust, grease, oil, or other foreign matter. Smooth and dry contact surfaces before installation of the filler. Install preformed joint filler in one continuous length. Before inserting the filler into the open joint, coat all sides of the material which will be in contact with concrete with a joint lubricant and adhesive recommended by the manufacturer of the filler material. Install the filler such that the top surface is 13 mm (1/2 in.) below the finished surface of the concrete pavement.

(c) Asphaltic Plug Expansion Joints. Manufacturers of asphaltic plug expansion joints are listed in the QPL.

Submit product information according to Subsection 105.02 for each joint before ordering. Product information shall consist of all material specifications including details, dimensions and detailed installation procedures. For joint rehabilitation applications, measure actual joint openings and include with the submittal.

Arrange for a trained technical representative from the joint manufacturer to be on site to help with preparatory operations and technical assistance during asphaltic plug expansion joint installation.

Remove existing joint materials, concrete, and plantmix as necessary to accommodate the installation of the asphaltic plug expansion joint as shown on the plans and as directed.

Prepare surfaces of removal and blockout areas as recommended by the joint manufacturer. Smooth and/or patch concrete surfaces to provide full and even bearing surfaces for the steel backing plate as recommended by the joint manufacturer and as approved.

Clean and dry entire blockout area and a width 150 mm (6 in.) along each side of the blockout using a hot compressed air lance capable of producing a temperature of 1650 °C (3000 °F) and a direction velocity of 914 m/s (3000 ft/s). Take care not to damage existing concrete.

Install backer rod in the joint opening. Place backer rod 25 mm (1 in.) below the bottom of the blockout area.

Fill from the top of the backer rod to the bottom of blockout with hot binder material. Fill from backer rod to face of barrier rail with polysulfide sealant.

Uniformly coat entire blockout area with hot binder material. Center steel plates over the joint opening and secure in place by inserting spikes through predrilled holes in the plate and backer rod. Abut adjacent steel plates and do not overlap. Coat exposed surfaces of the steel plates, spikes, blockout bottom, and sides of blockout with hot binder material to form a monolithic waterproof membrane.

Perform the following in accordance with the installation procedure:

1. Heat, mix, and proportion the aggregates and binder.
2. Place the blended asphalt mixture in layers and compact with small roller equipment.
3. Match the top layer with the grade of the bridge deck.
4. Seal final surface with hot binder material.

Provide a certificate of compliance by the joint manufacturer that the joints were installed in accordance with the joint manufacturer’s recommendations and installation procedures. Remove and replace any joint or portion of joint not meeting the joint manufacturer’s recommendations and installation procedures.

(d) Expansion Joint Sealant. Manufacturers of expansion joint sealant are listed in the QPL.

Form or saw cut the joint opening to the specified width and depth shown on the plans for placement of the expansion joint sealant. Form or saw cut the joint with a tolerance of plus zero and minus 3 mm (1/8 in.) between joint faces. Air blast all joint surfaces with abrasive and thoroughly clean the open joint with compressed air.

Keep the joint clean and free of loose material, dirt, dust, grease, oil, or other foreign matter. Smooth and dry contact surfaces before installation of the expansion joint sealant. Install the expansion joint sealant as shown on the plans, as specified herein, and as recommended by the manufacturer.

(e) Expansion Joint (Special). Manufacturers of expansion joint (special) are listed in the QPL.

Submit product information according to Subsection 105.02 for each joint before ordering. Product information shall consist of all material specifications including details, dimensions and detailed installation procedures. For joint rehabilitation applications, measure actual joint openings and include with the submittal.

Arrange for a trained technical representative from the joint manufacturer to be on site to help with preparatory operations and technical assistance during joint installation.

Prior to installing expansion joint (special), complete all deck patching, profile grinding, and deck overlay work.

Remove existing joint materials, concrete, and plantmix as necessary to accommodate the installation of the expansion joint (special) as shown on the plans and as directed.

Form or saw cut the joint opening to the specified width and depth shown on the plans for placement of the expansion joint (special). Form or saw cut the joint with a tolerance of plus zero and minus 3 mm (1/8 in.) between joint faces. Air blast all joint surfaces with abrasive and thoroughly clean the open joint with compressed air.

Keep the joint clean and free of loose material, dirt, dust, grease, oil, or other foreign matter. Smooth and dry contact surfaces before installation of the expansion joint (special). Install the expansion joint (special) as shown on the plans, as specified herein, and as recommended by the manufacturer.

Provide a certificate of compliance by the joint manufacturer that the joints were installed in accordance with the joint manufacturer's recommendations and installation procedures. Remove and replace any joint or portion of joint not meeting the joint manufacturer's recommendations and installation procedures.

(f) Preformed Elastomeric Joint Seal (Compression Joint Seal). Furnish and install preformed elastomeric joint seals with a lubricant adhesive. Preformed elastomeric joint seals shall conform to Subsection 707.03.05. The lubricant adhesive shall conform to ASTM D4070.

Submit product information according to Subsection 105.02 for each joint before ordering.

Install preformed elastomeric joint seals in saw cut grooves. Cut the sides of saw cut grooves simultaneously to a uniform width and depth. Remove all debris, concrete spillage, and foreign material from the groove. Repair all spalls, fractures, or voids in the concrete surfaces of the joint groove. Bevel the lips of the saw cut 6 mm (1/4 in.) by grinding. Before placement of the seal, clean the joint by abrasive blast cleaning and remove the residue by high pressure air jets. Protect water stops from the abrasive blasts.

Saw cutting is not required for armored metal joints. Joints installed in curbs, sidewalks, barrier rails, or railings will not require saw cutting provided the grooves are formed to the same dimensions as the saw cutting of the deck.

Make shop splices with no visible offset of exterior surfaces, and showing no evidence of bond failure. Do not field splice.

At the open ends of the seal, fill each cell to a depth of 75 mm (3 in.) with an open cell polyurethane foam or other approved material.

Install the seal with equipment which will not twist or distort the seal, elongate the seal longitudinally, or otherwise cause damage to the seal or to the concrete forming the groove. Install the seal in one continuous length.

Liberally apply lubricant adhesive to the sides of the seal and vertical surfaces of the groove immediately before installation, according to directions furnished by the manufacturer. Do not use material which has skinned over or which has settled in the containers, to the extent that it cannot be easily redispersed by hand stirring to form a smooth uniform product.

Install the seal so that its top edges are in a plane normal to the sides of the groove.

Furnish a Certificate of Compliance and a certified test report for each lot of preformed elastomeric joint seal and lubricant adhesive. In the certified test report for the elastomeric joint seals, include the movement rating of the seal. Have the testing performed by the manufacturer or an independent testing agency.

(g) Waterstops. Furnish and install waterstops according to the details shown on the plans. Support the edge of the waterstop in a satisfactory manner.

Manufacture waterstops from either natural rubber, synthetic rubber, or polyvinyl chloride (PVC), conforming to Subsection 707.03.03.

Manufacture waterstops with an integral cross section which is uniform within ± 3 mm (1/8 in.) in width, and with a web thickness or bulb diameter, within + 1.5 mm (1/16 in.) and – 0.8 mm (1/32 in.). Do not splice in straight strips. Cure strips, splices, and special connection pieces in a manner such that any cross section shall be dense, homogeneous, and free from all porosity. Fully mold all junctions in the special connection pieces. During the vulcanizing period, securely hold the joint by suitable clamps.

Use stainless steel parts to mechanically vulcanize field splices for natural or synthetic rubber waterstops, or use a rubber splicing union of the same stock as the waterstop. Construct finished splices with a tensile strength of 17.5 N/mm (100 lb/in.) of width. Form field splices for polyvinyl chloride waterstops by heat sealing the adjacent surfaces according to the manufacturer's recommendations. Use a thermostatically controlled electric source of heat to make all splices. Supply sufficient heat to melt but not char the plastic.

Cut and splice waterstops, at changes in direction to avoid buckling or distortion of the web or flange.

**502.03.14 Bearing Devices, Elastomeric Bearing Pads, and Bearing Surfaces.** Construct bridge bearing devices, assemblies, bearing pads, and items such as plates, bars, anchor bolts, expansion devices, and fixed devices in accordance with details and with materials shown on the plans. Structural steel and cast steel shall conform to Section 506, for those items. Elastomeric bearing pads shall conform to Section 725. Coat bearing devices as required in the contract documents, and in accordance with approved working drawings. If indicated on the plans, hot-dip galvanize devices after fabrication according to Section 715.

Submit working drawings for bearing devices and laminated bearings pads for review and approval according to Subsection 105.02. Do not fabricate bearings until the working drawings are approved. Include on the working drawings the NDOT contract number, bridge number shown on the plans, location on bridge, complete fabrication details, material designations, and supplier/manufacturer identification.

Supply plain (all elastomer) bearings or laminated bearings (consisting of layers of elastomer restrained at their interfaces by bonded steel laminates) as indicated on the plans and in accordance with this Subsection and Section 725. Bearings shall be individually cast with fully molded edges. Corners and edges of molded pads may be rounded at the option of the fabricator. Radius at corners shall not exceed 10 mm (3/8 in.) and radius of edges shall not exceed 3 mm (1/8 in.).

Plain pads may be cut from large sheets. Perform cutting in such a manner as to avoid heating of the material and to produce a smooth edge without tears or jagged areas.

Laminated bearings shall consist of alternating steel laminates and internal elastomer laminates with top and bottom elastomer covers. Steel laminates shall have a nominal thickness of 0.0747 inch (14 gage). Unless otherwise shown on the plans, internal elastomer laminates shall have a thickness of 12.5 mm (1/2 in.). Top and bottom elastomer covers shall each have a thickness of 6 mm (1/4 in.). The elastomer cover to the steel laminates at the sides of the bearing shall be 3 mm (1/8 in.) for bearings heights of 150 mm (6 in.) or less and 6 mm (1/4 in.) for other bearing heights. If guide pins or other devices are used to control the side cover over the steel laminates, exposed portions of the steel laminates shall be sealed by vulcanized patching.

Construct and finish concrete surfaces to provide a true and even surface for bearing devices, assemblies, and bearing pads. For bearing devices, assemblies, or masonry plates to be placed (not embedded) directly on concrete, construct the concrete bearing area slightly above grade and finish by grinding or other approved means to a true level plane which shall not vary perceptibly from a straightedge placed in any direction across the area. For elastomeric bearing pads, wood float finish the concrete surfaces on which pads are to be placed to a level plane which shall not vary more than 1.5 mm (1/16 in.) from a straightedge placed in any direction across the area. Construct the finished plane to within 3 mm (1/8 in.) of the elevation shown on the plans.

Set bridge bearing devices, assemblies and bearing pads in the positions as shown on the plans and with full and even bearing on the masonry or grout pads. Do not place bridge bearings on masonry bearing areas or grout pads which are irregular or improperly formed. Set bearing devices and pads level, unless noted otherwise. Set expansion devices to conform to the temperature at the time of erection or to the setting specified.

Drill the holes and set the anchor bolts, except where the holes are formed or the bolts are built into the masonry. Set the bolts accurately and fix with Portland cement grout, completely filling the holes.

Adjust the location of the anchor bolts in relation to the slotted holes in the expansion shoes to correspond with the temperature at the time of erection. Adjust the nuts on the anchor bolts at the expansion ends of spans to permit free movement of the span.

Unless otherwise noted, apply a layer of graphite grease to surfaces designed for sliding movement when placing such devices in the structure.

**502.03.15 Concrete Patching and Repair.** After removal of forms, cut back all metal ties except those to be used to aid future forming, evaluate finished surfaces, and correct defects. Excessive defects or defects that affect the member's structural integrity, as determined by the Engineer, will be sufficient cause for rejection of all or a part of the structure.

If it is determined that a defect is a cosmetic or minor defect, patch as described herein. Chip loose or broken material away until a dense, uniform surface exposing solid coarse aggregate is obtained. Cut away feathered edges to form a face perpendicular to the surface being patched. Thoroughly saturate all surfaces of the cavity with water. Coat contact surfaces with an approved bonding agent. Bonding agent may be mixed with mortar in lieu of coating the contact surfaces.

Patching mortar shall consist of 1 part Portland cement and 2 parts mortar aggregate by volume. Add only enough water to the mortar to permit placing and packing. Use white cement or other approved tinting materials on all surfaces where an "ordinary finish" is the final finish. For patching large or deep areas, add coarse aggregate to the patching mortar.

Thoroughly tamp the patching mortar into place. Mortar may be placed pneumatically when approved. Float the surface of the mortar with a wooden float before initial set takes place. The patch shall present a neat and workmanlike appearance.

Cure the patched surface by one of the methods described in Subsection 501.03.08.

If it is determined that a defect is a major defect, submit an engineering evaluation and repair proposal for approval. Allow 14 days for proposal review and final disposition. Do not commence repairs to major defects before receiving written approval of the proposal. Include the following information in the proposal:

1. Cover letter indicating that the proposal has been prepared under the direction of an engineer who is registered as a Civil or Structural Engineer in the State of Nevada.
2. Description of the products addressed as part of the proposal with complete details of the defects.
3. Description of the proposed repair procedures including materials, preparation, and curing.
4. Structural assessment of the repaired product's ability to perform its intended function.
5. Assessment of durability of the repaired product relative to similar, defect-free products.
6. Supportive information, pictures, and sketches.

Repair the defect according to the approved repair procedure and as directed.

When requested, provide a signed and sealed statement from the registered engineer who prepared the proposal that they have physically inspected the repairs and attest the repairs have been performed in full conformance with the approved proposal.

When an item of "Concrete Bridge Deck Repair" is included in the proposal, give 2 weeks notification in advance of the anticipated date that the existing bridge decks will be exposed and available for inspection and testing to determine the extent of defective areas requiring repair. Accomplish repair of existing concrete bridge decks as hereinafter provided:

(a) The areas to be repaired will be designated. Break and remove the concrete to such depth that sound concrete is exposed over the entire area. Limit the mass of pneumatic hammers to a maximum of 16 kg (35 lb) for concrete removal. Excavate edges of the repair area in a manner that will result in an approximately vertical face and not a feathered edge. Do not saw cut around the perimeter of the repair unless shown on the plans or otherwise directed. Exercise care to prevent damage to reinforcing steel and concrete which will remain in place.

(b) After loose material has been removed, blow out the excavation with compressed air or flush with water. Remove excess water. Do not allow oil from the compressor to be deposited on the contact surfaces.

(c) If reinforcing steel contains rust, remove all visible rust by air blasting with abrasive. Apply an approved spray-on corrosion inhibitor according to the manufacture's recommendations.

(d) Following cleaning of the excavated area and before placement of the concrete repair material, apply an approved bonding adhesive to the repair area. Apply the bonding adhesive according to the manufacturer's recommendations and instructions.

(e) Use repair materials as specified in the contract documents.

(f) Unless otherwise approved, use a vibrating screed to consolidate all concrete repairs regardless of thickness and do not use a bull float. Except as hereinafter set forth for joints, the finish obtained by the vibrating screed shall be considered the final finish.

(g) Duplicate all joints in the original slab and provide joints between the repair and any abutting slabs in a manner that will allow the repair to move identically with the base slab.

(h) Commence curing immediately upon completion of finishing. Cure repairs as recommended by the manufacturer of the repair material, according to Subsection 501.03.08, and as directed.

**502.03.16 Finish of Horizontal Surfaces.** Construct concrete bridge decks and approach slabs to the requirements of this Subsection. Strike off and consolidate concrete to provide the proper grade and cross section and finish to a smooth, even surface. Do not produce variations that will prevent drainage from any part of the deck. Correct the surface by grinding the high areas as specified herein. Use an edging tool at nonarmored deck edges. The term finishing equipment as used in this Subsection refers to both finishing machines and finishing bridges.

Limit the rate of placing concrete to that which can be finished before the beginning of initial set. Do not place bridge deck concrete until the Engineer is satisfied that the rate of producing and placing concrete will be sufficient to complete the placing and finishing operations within the scheduled time, that a sufficient number of experienced finishing equipment operators and concrete finishers are employed, that fogging equipment and all necessary finishing tools and equipment are on hand at the site of the work and in satisfactory condition for use. Set up and demonstrate proper working condition of the finishing equipment to permit inspection during the daylight hours before each pour. Provide adequate lighting facilities if it is determined that concrete placement and finishing operations may not be completed during daylight hours.

Should settlement or other unanticipated events occur, which in the opinion of the Engineer would prevent obtaining a bridge deck conforming to the requirements of these specifications, discontinue placing of deck concrete until satisfactory corrective measures are provided. In the event satisfactory measures are not provided before initial set of the concrete in the affected area, discontinue the placing of concrete and install a bulkhead at a location determined by the Engineer. Immediately remove all concrete in place within the affected area.

Unless otherwise specified in the plans, after placing and consolidating the concrete, use a finishing machine to perform concrete strike off, finishing and texturing. Use a self propelled mechanical finishing machine capable of forward and reverse movement under positive control. The finishing machine shall be equipped with a rotating cylindrical single or double drum screed not more than 1.5 m (5 ft) in length, operating transversely to the bridge centerline. It shall have the necessary adjustments to produce the required cross section and grade and shall allow all screeds to be raised and lowered under positive control. The upper vertical limit of screed travel shall permit the screed to clear the finished concrete surface. Use hand tools operated from finishing bridge to supplement the finishing machine as specified or otherwise permitted.

Provide at least one finishing bridge of rigid construction, free of wobble and springing under operation and easily moveable. Provide additional finishing bridges as necessary to complete finishing operations without undue delay or as otherwise directed.

Support finishing equipment on adjustable steel rails or pipes set to elevations to provide a bridge deck surface true to the required grade and cross section. Provide rails that will not result in any appreciable deflection due to the mass of the finishing equipment under operation. Locate rails beyond the perimeter of concrete placement such that finishing equipment may operate without interruption over the entire bridge deck being finished and permit the screed of the finishing machine to fully clear the ends of concrete to be placed. Unless otherwise permitted, locate rail supports completely outside the pour area such that support hardware is not required to be left within or

removed from the placed concrete. Do not weld the rail supports to any portion of the structure. Set rail elevations with an allowance for anticipated settlement, camber, and falsework deflection. Verify the adjustment and operation of deck finishing equipment and support rails by moving the finishing bridge and finishing machine over the full length of the deck section to be placed and traversing the float completely across all end bulkheads before placement of concrete is begun.

Unless otherwise permitted, operate the finishing machine to place and strike off bridge deck concrete along a line parallel to the bridge abutments or piers. Do not place concrete more than 3 m (10 ft) ahead of strike off. Complete strike off and consolidation within 15 minutes after the concrete is placed. When the plans specify that decks may be hand finished, strike off placed concrete to the appropriate grade and cross section using a metal or metal-clad template. Concrete surfaces under sidewalks and railings may be struck off by hand to the appropriate grade and left unfinished.

When the plans specify that decks may be hand finished, follow concrete strike off with hand operated longitudinal floating to obtain a smooth riding surface using wooden float boards that are ribbed or trussed to provide necessary rigidity. Operate the longitudinal floats, with the long axis of the float parallel to the centerline of the bridge roadway. Operate the float with a combined longitudinal and transverse motion planing off the high areas and floating the material removed into the low areas. Lap each pass of the float's previous pass by half the length of the float. Continue floating until a smooth riding surface is obtained. Maintain float boards free of twist and true at all times.

Finish the surface adjacent to the curb or barrier rail to a smooth troweled texture approximately 300 mm (12 in.) from the face of the curb or barrier rail on the low side or sides of the deck as approved.

After floating, and in advance of the curing operations, texture the concrete surface with a drag strip of burlap or other suitable material.

Immediately following completion of the deck finishing operations, cure the concrete in the deck as specified in Subsection 501.03.08.

Unless the bridge deck and approach slabs are overlayed with a bituminous surface, furnish and operate a California type profilograph which meets the requirements of Subsection 402.03.03. Measure the finished concrete surfaces as well as the adjacent 10 m (30 ft) of the approach surface according to Test Method No. Nev. T446, Part II "Determination of High Points" with the exception that the high points shall not exceed 6 mm (0.25 in.). Remove all high areas in excess of 6 mm (0.25 in.) from the hardened concrete surface by abrasive means until the measured deviations, as indicated by reruns of the profilograph, do not exceed 6 mm (0.25 in.).

There shall be a minimum 2 profiles per lane, each 1 m (3 ft) from the lane lines and one profile for each shoulder approximately 1 m (3 ft) from the curb or rail face. All profilograph runs shall be made in a direction parallel to and in the direction of traffic. In addition, when a straightedge 3.6 m (12 ft) long is laid on the finished surface at right angles to the centerline and extending from edge to edge of traffic lane, the surface shall not vary more than 3 mm (0.01 ft) from the lower edge of the straight edge. When a straightedge 3.6 m (12 ft) long is laid on the finished surface parallel with the centerline of the bridge deck and approach slabs, the surface shall not vary more than 3 mm (0.01 ft) from the lower edge of the straightedge.

When the bridge deck and approach slab concrete are indicated to be covered by bituminous surfacing or other surfacing 25 mm (1 in.) or more in thickness, the concrete surfaces shall not vary more than 9 mm (0.03 ft) from the lower edge of a 3.6 m (12 ft) long straightedge placed transversely to traffic between lane lines. The concrete surface shall also not vary more than 9 mm (0.03 ft) from the lower edge of a 3.6 m (12 ft) long straightedge placed parallel with the centerline of the bridge deck and approach slabs. Place plantmix bituminous surfacing and correct all high areas according to Subsections 402.03.05 and 403.03.04.

Perform grinding in accordance with Subsection 409.03.12. Produce ground areas of uniform texture and of neat and approximately rectangular patterns which extend laterally to the nearest lane line or edge and longitudinally to lines normal to the centerline. Restore proper drainage by feathering the grinding as directed.

Apply a grooved finish to concrete bridge decks and approach slabs as described herein unless otherwise indicated in the plans. Groove the concrete deck slab after the concrete deck has been cured and has attained a 21 MPa (3,000 psi) compressive strength and after any grinding to meet surface tolerances.

Perform grooving using diamond blades, mounted on a multi-blade arbor on a self-propelled machine which has been built for grooving concrete pavement. Provide a machine with a depth control device, which will detect variations in the pavement surface and adjust the cutting head height to maintain the depth of groove specified. The grooving device shall have devices to control alignment. The machine shall have a recoverable water system.

Cut the grooves parallel to the centerline of the bridge. Run grooves continuous to not less than 300 mm (12 in.) nor more than 375 mm (15 in.) from the deck edge, parapet, gutter, or barrier rail on each side of the bridge deck. Terminate grooves a maximum of 300 mm (12 in.) from expansion joints or any devices imbedded in the pavement, such as metal joints, access plates, etc. Line up the grooves across construction joints or stopping points to produce grooves that are continuous across the entire surface.

Make grooves of rectangular cross section and of sufficient thickness and resilience to result in grooves spaced 19 mm (3/4 in.) on center, 2 to 3 mm (3/32 to 1/8 in.) wide and 3 to 5 mm (1/8 to 3/16 in.) deep in the finished concrete surface.

Provide an experienced technical representative to assist the Contractor and Engineer during the initial operation and/or subsequent operations if necessitated by special conditions, including, but not limited to, location, alignment, dimensional control, coverage and groove spacing consistency.

Construct the top and face of the finished parapet and curb true and straight, and the top surface of uniform width, free from humps, sags, or other irregularities. When a straightedge 3.6 m (12 ft) long is laid on top of the face of the curb or on the face of the parapet, the surface shall not vary more than 3 mm (0.01 ft) from the theoretical grade or alignment in 3.6 m (12 ft), except that proper allowance shall be made for curves and camber.

**502.03.17 Formed Surfaces Requiring Finishing.** Give all exposed surfaces of structures an ordinary surface finish unless otherwise specified or directed. Finish exposed surfaces of structures to 0.3 m (1 ft) below finished grade. Surfaces designated to receive an exposed aggregate finish need not be finished.

The inside of the culvert barrels, except for a horizontal distance into the ends equal to the height when the end of culvert may be seen from a traveled way, will not be defined as an exposed surface.

**502.03.18 Ordinary Surface Finish.** Repair the surface of all holes left by form ties and other holes 6 mm (0.25 in.) or more in largest diameter according to Subsection 502.03.15. Produce a surface true and even, free from stone pockets, depressions, or projections beyond the surface. Knock off or grind flush all fins and projections. Fill offsets greater than 3 mm (0.125 in.) or taper back to present a smooth appearance. Make patches of such color and appearance that will blend with the surrounding surface.

Except as provided herein, remove all form bolts and any metal placed for convenience to a depth of at least 25 mm (1 in.) below the surface of the concrete. Remove rock pockets and other unsound concrete. Clean and fill the resulting holes or depressions with mortar. Remove all form bolts projecting into the cells of box girders flush or below the surface of the concrete.

Finish the surfaces to produce smooth even surfaces of uniform texture and appearance, free of unsightly bulges, depressions, and other imperfections.

Sand areas which do not exhibit the required smooth, even surface of uniform texture and appearance with power sanders or other approved abrasive means until smooth, even surfaces of uniform texture and appearance are obtained. The use of power carborundum stones or disks may be required to remove bulges and other imperfections.

**502.03.19 Fine Surface Finish.** Before applying fine surface finish, prepare the surface according to Subsection 502.03.18.

Use a fine surface finish (bonded grout) product listed in the QPL.

Furnish a certificate of compliance according to Subsection 106.05, technical data sheets, material analysis data, the manufacturer's recommendations for methods of placement and equipment, and Material Safety Data Sheet (MSDS). Deliver certificates and information at least 20 working days in advance of providing the fully cured test panel for evaluation as specified below.

Prepare and package manufactured concrete surface finishing material at the factory. The material shall be ready for application. Do not thin or dilute the material after the material has been shipped.

Label all containers listing the exact title of the specification, the color of the material, the type of finish and texture, manufacturer's name, date of manufacture, manufacturer's batch or lot number, and expiration date for the batch or lot. The label shall show precautions concerning the handling and application of the material. Deliver the coating to the job site in sealed containers bearing the manufacturer's original labels.

Store material in airtight, upright containers according to Subsection 106.08 and at atmospheric temperatures between 10 and 32 °C (50 and 90 °F). A minimum of 24 hours prior to application, store the product according to manufacturer's recommendations.

A minimum of 30 days prior to application, provide a fully cured 1.2 m x 2.4 m (4 foot by 8 foot) concrete test panel that is of the same type of concrete that will be coated. Prepare the surface to receive the fine surface finish according to the manufacturer's recommendations and as specified herein. The color of the material shall be as shown on the plans. Prepare surfaces and apply the material to the test panel according to the manufacturer's recommendations. Several test panels with different shades of color or variance of shades on the same test panel may be required to make a final color selection. Do not apply fine surface finish to structures designated for coating until the color is approved in writing. Once a color has been selected, do not deviate from the color specific to the manufacturer's product or the application rate used on the test panel.

Do not apply the material unless surface and atmospheric temperatures are at least 7 °C (45 °F) and rising. Do not apply if the surface and atmospheric temperatures are above 35 °C (95 °F). Do not apply if rain, snow, or freezing temperatures are imminent within 24 hours. Do not apply in winds that can cause the application of material to be compromised. Additional surface and atmospheric temperature limitations may be required per manufacturer's recommendations.

Thoroughly clean concrete surfaces just before applying fine surface finish. The concrete surfaces shall be free of efflorescence, chemical compounds, form waxes, release agents, curing compounds, oil, flaking coatings, and other deleterious substances. The application of a 10% solution of muriatic acid or a 25% zinc sulfate solution to clean and lightly etch the surface is permitted; or an abrasive method may be used as approved. Thoroughly rinse the concrete surface with potable water after cleaning and allow the concrete surface to dry.

The material shall be applied to a dry concrete surface that has aged or cured for a minimum of 28 days.

Thoroughly mix the material in its original container. Remove skins prior to mixing or use.

Apply the material according to the manufacturer's recommendations and with manufacturer certified personnel.

Spray the material to provide a uniform appearance in color and texture that is tightly bonded to the concrete surface. The material shall show no evidence of sagging, running, wrinkling, or other film defects.

Construct the fine surface finish with qualified personnel at an application rate and with the number of coats specified in the manufacturer's recommendations. Apply the manufacturer's compatible prime coat if specified by the manufacturer for porous surfaces or in hot, windy conditions.

Apply the material by spray, using conventional spray equipment with a 6 mm (0.25 in.) round spray head. Supply material by either a surge pump with a 12 to 1 ratio or an auger type pump, with air pressure sufficient to achieve uniform texture. Replace worn spray heads as required to achieve a uniform finish.

The fine surface finish shall adhere to the concrete surface without chipping, flaking, or peeling. Material that does not adhere to the concrete surface or does not attain the desired surface appearance will be rejected. Entirely remove unacceptable fine surface finish from the concrete surface. Thoroughly clean and properly prepare the concrete surface and reapply the fine surface finish until the desired surface finish is achieved.

If the concrete surface is to receive reflective markers, install markers by one of the following methods:

1. Install markers with a protective covering before application of the fine surface finish and remove the protective covering after the material has cured.

2. Mask the clean concrete surface at the locations where the reflective markers are to be installed before application of the fine surface finish. After the material has cured, install the reflective markers after removing the masking material.

3. Install markers after thoroughly removing the newly applied fine surface finish at the areas where the reflective markers are to be installed.

Protect pedestrians, traffic, surrounding surfaces, and other appurtenances from overspray, splashing, and drips with suitable methods prior to fine surface finish application. Remove protection methods within 24 hours after the material has cured. Clean overspray, splashes, and drips by approved methods. The use of a mechanical abrasion technique for removal may be required. Satisfactorily clean, restore, or replace unacceptable surfaces as directed.

**502.03.20 Formed Exposed Aggregate Finish.** Give forms for surfaces which are to receive an exposed aggregate finish a minimum of 2 coats of retardant of sufficient strength to cause a 6 mm (0.25 in.) total etch to the finished surface.

Remove forms from all concrete surfaces requiring an exposed aggregate finish within 14 days after placement of the concrete.

Soon after stripping the forms, wash the concrete to remove all loose material and otherwise clean to provide the specified 6 mm (0.25 in.) etch as approved.

Sandblasting will be permitted for blending purposes only. Should major amounts of sandblasting be required, treat the entire area as approved. Accomplish sandblasting, if permitted or required, as soon after completion of the washing phase as is practical.

Seal exposed aggregate surfaces with a clear non-silicone product with solids completely dissolved. Use a non-staining product which does not form a surface residue after curing. The solids shall become an integral part of the masonry and shall be of a non-diminishing type. Products which require agitation will not be accepted. Apply the sealer at the rate recommended by the manufacturer, and as approved.

Construct a 0.6 m (2 ft) by 0.6 m (2 ft) exposed aggregate test panel before placing concrete. This panel will be used to test the acceptability of the exposed aggregate finish and upon approval, shall become a referee panel and the property of the Department. Replace rejected panels with new samples, for approval. Exposed aggregate surfaces shall conform to the referee panel.

**502.03.21 Application of Loads.** Do not allow traffic, construction equipment, or construction materials on any portion of a conventionally reinforced structure until the concrete has attained a minimum age of 10 days and the required 28 day strength.

Do not allow traffic, construction equipment, or materials on any portion of a post-tensioned structure until the concrete has attained a minimum age of 14 days and the required 28 day strength and all post-tensioning and grouting has been completed.

Do not allow traffic, construction equipment, or materials on approach slabs until the concrete has attained a minimum age of 7 days and 80% of the required 28 day strength.

Upon approval, light construction equipment and materials may be carried on bridge decks provided the concrete has been in place for not less than 24 hours and that curing is not interfered with and the surface texture is not damaged.

In cold weather, increase the above specified time requirement one day for every day the curing time is increased as prescribed in Subsection 501.03.09 (b).

**502.03.22 Permanent Concrete Barrier Rail.** Construct concrete barrier rail of the type shown on the plans by either of the following methods:

(a) Cast-in-Place Method. Concrete barrier rails constructed by casting-in-place shall conform to the provisions in this Section.

(b) Extrusion Method. Concrete barrier rails constructed by using an extrusion machine or other similar type equipment shall be of well compacted dense concrete. Evidence of successful operation of the extrusion machine or other equipment may be required before commencement of work.

Vibrate, ram, tamp, or work the concrete with suitable appliances until the concrete has been consolidated to the maximum practicable density, free of rock pockets, and snug against the pre-formed surfaces. In conjunction with said method of consolidation, operate the equipment under sufficient uniform restraint to forward motion to produce the required consolidation.

Produce concrete of such consistency that after extrusion it will maintain the shape of the barrier rail without support.

Set an offset guideline to indicate the grade for the top of the concrete barrier rail from established survey marks. Make the forming portion of the extrusion machine readily adjustable horizontally and vertically during the forward motion of the machine to conform to the predetermined grade line. Attach a grade line gage or pointer to the machine in such a manner that a continual comparison can be made between the barrier rail being placed to the established grade line as indicated by the offset guide line.

Instead of the above method for maintaining the barrier rail grade, the extrusion machine may be operated on rails or forms set at a uniform depth below the predetermined finished top of the barrier grade, or on existing pavement or bridge decks.

Do not combine cast-in-place and extruded barrier rail within a given “run” unless otherwise approved.

Construct concrete barrier rail with a smooth, uniform appearance and conforming to the horizontal and vertical lines shown on the plans. Construct the concrete barrier rail true, straight, and of uniform width, free of humps, sags, and other irregularities.

When a straightedge 3.6 m (12 ft) long is laid on top of the barrier rail, the surface shall not vary more than 6 mm (0.25 in.) from the edge of the straight edge on the theoretical grade, except that proper allowances shall be made for curves. When a straightedge 3.6 m (12 ft) long is laid along the face of the barrier rail, the surface shall not vary more than 12.5 mm (0.5 in.) from the edge of the straightedge on the theoretical alignment, except that proper allowances shall be made for curves.

Construct expansion joints only at structures. Construct expansion joints of the width shown on the plans by sawing or forming through the barrier section to its full depth. Insertion of joint filler is not required.

When expansion joints are not constructed by sawing, construct the expansion joints as provided in these specifications.

If sawing or forming joints is performed before the concrete has hardened, support firmly the adjacent portions of the barrier rail with close fitting shields.

If the optional horizontal construction joint is used and the footing is poured immediately ahead of the extruded portion of the barrier rail, the required 200 mm (8 in.) dowels may be omitted provided the barrier is placed before the concrete in the footing has attained the initial set.

If extrusion methods of placement are used, place the horizontal reinforcing bars continuously.

Place one-way or two-way reflective markers on top of the concrete barrier rail according to Standard Plan Sheet No. R-9.2.2. One-way and two-way reflectors and their colors shall conform to the requirements of the MUTCD. Use reflective markers listed in Subsection 625.02.02.

The binding agent (epoxy) used for fastening the reflective markers to the top of the concrete barrier rail shall conform to Subsection 728.03.04.

The joint sealer along the edges of concrete barrier rail shown on Standard Plan Sheet No. R-8.6.1 shall be one of the single component, hot applied sealants (Asphalt and Ground Rubber) listed in the QPL.

**502.03.23 Portable Precast Concrete Barrier Rail.** Construct new portable precast concrete barrier rail or use State-furnished if so specified.

Construct portable precast concrete barrier rail according to the plans and these specifications.

The barrier rail shall be true, straight, and free of lumps, sags, and other irregularities. When a straight edge 3.6 m (12 ft) long is laid on top of the barrier rail, the surface shall not vary more than 6 mm (0.25 in.) from the edge of the straight edge. When a straight edge 3.6 m (12 ft) long is laid along the face of the barrier rail, the surface shall not vary more than 12.5 mm (0.5 in.) from the edge of the straight edge. Allow inspection of the barrier rail prior to delivery.

Obtain State-furnished portable precast concrete barrier rail from storage, at locations specified.

In either case, remove and stockpile all materials at the locations specified when the portable precast concrete barrier rail is no longer required, and said portable precast concrete barrier rail shall remain or become the property of the State.

Reflectorize portable precast concrete barrier rail by placement of a two-way reflector in the center of each barrier rail section and located on top of the rail. Color of the reflectors shall conform to the MUTCD. Use reflective markers listed in Subsection 625.02.02.

**502.03.24 Precast Concrete Box Culverts.** Precast reinforced concrete box culverts may also be furnished in lieu of the cast-in-place method.

Design and construct square or rectangular monolithic precast reinforced concrete boxes conforming to ASTM C1577, as controlled by the height of cover shown on the plans and as specified herein. If the cover shown on the plans is less than 3 m (10 ft), design the structure for the full range of live and dead loads from zero to 3 m (10 ft) of cover. If the cover shown on the plans is 3 m (10 ft) or greater, design the structure for the cover shown on the plans plus an additional 1.5 m (5 ft) of cover. Where a design height is specified on the plans, design the structure for the height specified. Indicate the design cover and loading in the working drawing submittal. Use the same box design for each individual run. If approved, minor deviations from the design dimensions may be allowed in order to conform to manufacturing processes.

Submit design calculations and working drawings for the precast concrete boxes for review and approval according to Subsection 105.02. Include on the working drawings the contract number, the jobsite name of the structure as shown on the plans, bridge number (if applicable), material designations, bill of materials, complete fabrication details, and guidelines for handling, assembly, and fabrication. Calculations and working drawings shall be prepared and stamped by a Nevada Registered Professional Civil Engineer.

(a) Manufacturer Certification and Qualification. Have the manufacturer of precast reinforced concrete box sections submit for approval the following evidence of qualification to produce the product:

1. Certification of the precast concrete facility as specified in Subsection 106.07.

2. Written evidence of successful completion of at least 3 projects of similar size and scope. The projects shall have been performed within the previous 3 years. Such evidence shall include owner references with current contact information.

3. A written document detailing the manufacturer's Quality Control Program which demonstrates conformance to the requirements of these specifications.

(b) Concrete. Concrete shall conform to Section 501 and the following:

1. When a wet cast manufacturing process is used, concrete shall be Class AA Modified, except in Clark County where concrete shall be Class A Modified or Class AA Modified. A wet cast manufacturing process is defined as one in which forms are removed after 6 hours or more.

2. When a dry cast manufacturing process is used, concrete shall be Class A Modified. A dry cast manufacturing process is defined as one in which the concrete is densified by continuous vibration, and forms are removed immediately. If approved, alternate aggregate gradations from those specified in Section 501 and Section 706 may be allowed.

Submit for review and approval a copy of the concrete mix design which will be used for the manufacture of the precast box sections. The concrete mix design shall follow the requirements set forth in Section 501 and shall identify whether the wet cast or dry cast process will be utilized.

(c) Product Certification. Submit a certificate of compliance issued by the manufacturer of the precast reinforced concrete box sections at the time of shipment. The certificate shall include the following:

1. The specification under which the box sections were designed and manufactured.

2. The NDOT contract number for which the box sections were designed and manufactured.

3. The number of box sections of each size which are being shipped.

4. A statement that the design and construction of the box sections, and all materials used therein, are in compliance with the requirements of the applicable ASTM or AASHTO specifications.

The manufacturer of the precast reinforced concrete box sections shall maintain, for a period of one year following shipment, a copy of the appropriate test reports and other documentation necessary to support the certificates of compliance.

(d) Construction. Give written notification 2 weeks in advance of performing casting operations.

Carefully handle concrete boxes in loading, unloading, transporting, and laying.

Do not lay boxes which are cracked, checked, spalled, or damaged, and permanently remove all such sections from the work. Boxes which show defects due to handling will be rejected at the site of installation regardless of prior acceptance.

Fine cracks and checks on the surface of the member which do not extend to the plane of the nearest reinforcement will not be cause for rejection unless they are numerous and extensive. Repair cracks which extend into the plane of the reinforcing steel, but are acceptable otherwise, in an approved manner.

Repair small damaged or honeycombed areas, which are purely surface in nature. Excessive damage, honeycomb, or cracking will be subject to structural review. Make sound repairs, properly finish, and cure in conformance with the pertinent specifications. When fine cracks or hairchecks on the surface indicate poor curing practices, discontinue further production of precast boxes until corrections are made and proper curing provided.

Bed the boxes as shown on the plans.

Begin the placing of the boxes at the downstream end of the line. Place the grooved ends of the box segments facing upstream. Place the bottom of the segments in full contact with the prepared bedding. Check the box segments for alignment and grade at the time of joining the sections.

Keep the interior of the boxes free of dirt and other foreign material as the box laying progresses, and leave clean at the completion of the work. Take up and relay any box which is not in true alignment, which shows any undue settlement after laying, or is damaged.

Box culverts shall be installed with tongue and groove joints or gasketed joints. Box culverts specified to have watertight joints shall be installed with gasketed joints. Tongue and groove joints and gasketed joints shall conform to Subsection 707.03.02.

Install boxes, sealants, and gaskets as specified by the manufacturer. Submit a copy of the manufacturer's installation instructions prior to installation. Lubricate gaskets requiring lubricant with the lubricant recommended by the manufacturer.

Join the box segments in such a manner that the ends are fully entered and the inner surfaces are flush and even. The maximum tolerable gap in the joints shall be 19 mm (0.75 in.) or the manufacturer's maximum joint gap tolerance, whichever is less, checked immediately after making each joint. If any annular space exists in the interior portion of the joint, fill with an approved mortar. Finish the mortar flush with the interior surfaces of the box units.

For multiple box installations, solidly fill the 75 mm (3 in.) space between the box lines with grout. Use grout of workable mix suitable for pumping without segregation. Place the grout by pumping or an approved alternate method. Consolidate the grout by mechanical vibration or rodding during placing. Perform the grouting in a continuous pour in lifts not exceeding 1.8 m (6 ft). Vertical grout barriers may be used to control the flow of grout horizontally. The grout shall attain a minimum compressive strength of 17 MPa (2,500 psi) in 28 days when tested according to ASTM C39.

METHOD OF MEASUREMENT

**502.04.01 Measurement.** Concrete will be measured by the cubic meter (cubic yard).

Fine surface finish will be measured by the square meter (square yard).

The estimated quantities shown on the plans for concrete and fine surface finish, plus or minus authorized quantity changes, will be the quantity used for payment. The Engineer or the Contractor may, however, request final measurement. Submit request for final measurement in writing. When final measurement is made the quantities derived therefrom will be the quantities used for payment.

The estimated quantities shown on the plans for reinforced concrete box culverts will be based upon dimensions required for cast-in-place construction, regardless of said method being optional. There will be no adjustment of quantities due to the optional use of the precast method.

If Portland cement concrete is placed and is shown by test to be below the specified 28 day compressive strength, the Engineer will determine as to whether the concrete shall be removed and replaced or allowed to remain in place. This determination will be based on an evaluation of the durability and other qualities of the concrete necessary to the integrity of the structure. If the concrete is allowed to remain in place, the Department will deduct from money due, or to become due to the Contractor from the Department, a percentage of the unit bid price. This deduction shall be considered to be liquidated damages and shall be at a rate of 3% of the contract unit bid price for each 1% (rounded to the nearest 1%) below 95% of the 28 day compressive strength to a maximum of 30% of the unit bid price, as set forth in the following example.

| Percent of Specified 28 Day Compressive Strength | Examples MPa (psi) | | | Liquidated Damage Per Unit Bid Price |
|---|---|---|---|---|
| 100 | 21.0 (3,000) | — | 31.0 (4,500) | 0 |
| 95 | 20.0 (2,850) | — | 29.5 (4,275) | 0 |
| 94 | 19.7 (2,820) | — | 29.2 (4,230) | 3 |
| 93 | 19.5 (2,790) | — | 28.9 (4,185) | 6 |
| 92 | 19.3 (2,760) | — | 28.5 (4,140) | 9 |
| 91 | 19.1 (2,730) | — | 28.2 (4,095) | 12 |
| 90 | 18.9 (2,700) | — | 27.9 (4,050) | 15 |
| 89 | 18.7 (2,670) | — | 27.6 (4,005) | 18 |
| 88 | 18.5 (2,640) | — | 27.3 (3,960) | 21 |
| 87 | 18.3 (2,610) | — | 27.0 (3,915) | 24 |
| 86 | 18.1 (2,580) | — | 26.7 (3,870) | 27 |
| 85 | 17.9 (2,550) | — | 26.4 (3,825) | 30 |

The reduced price shall apply to all concrete represented by the strength tests below the specified minimum compressive strength.

If directed, remove and replace concrete represented by the strength tests below the specified minimum compressive strength.

When a compressive strength test falls below the specified 28 day compressive strength, the Department may determine that an alternate strength test is required or the Contractor may request such test. When the Department determines that an alternate strength test is required, the Contractor will not be liable for the cost of such test. If the Contractor elects to have an alternate strength test made, the Department will then make such a test; however, should this test fail to indicate that the 28 day compressive strength requirements have been met, the cost thereof shall be deducted from any money due or to become due the Contractor. The Contractor shall request an alternate strength test no later than 14 days after receiving the failing compressive strength test result.

The alternate strength test shall consist of obtaining and testing 3 drilled core samples according to ASTM C42. The test specimens will be taken at a single suitable location, and shall be from the same area represented by the original strength test. The cores will be obtained and the test performed by the Department. The compressive strength used for evaluation of the concrete shall be the average of the compressive strength of the three cores.

This calculated value shall be termed the “result of the core test.” When the result of the core test validates the original 28 day strength test, the quality of the concrete shall be assessed on the basis of the original test. When the core test does not validate the 28 day strength, then the result of the core test will be used to assess the quality of the concrete.

The quantity of concrete involved in fillets, scorings, and chamfers 1,300 $mm^2$ (2 $in.^2$) or less in cross sectional area will be neglected. No deduction will be made for the volume of concrete displaced by reinforcing steel, expansion joint material, drainage, and weep holes. The volume of concrete displaced by pipes, conduits, ducts (except that no deduction shall be made for prestressing ducts), and forms for voids embedded in concrete that are in excess of 1,300 $mm^2$ (2 $in.^2$) in cross sectional area will be deducted. Deduction will be made for the volume of timber piles, concrete piles, and cast-in-place piles embedded in the concrete.

No measurements or other allowances will be made for work, material, or additional concrete required for the use of stay-in-place metal forms.

Tremie seal concrete will be measured by the cubic meter (cubic yard), based on batched volume placed.

Concrete bridge deck repair will be measured by the force account according to Subsection 109.03.

Permanent and portable precast concrete barrier rail will be measured by the linear meter (linear foot).

Portable concrete barrier rail will be measured one time only, for its initial installation, and movement of the rail from one location to another shall be considered necessary and essential and shall not constitute grounds for remeasurement.

Precast concrete box culverts will be measured by the linear meter (linear foot) of the size specified.

Compression joint seals, strip seal expansion joints, preformed joint filler, asphaltic plug expansion joints, expansion joint (special), and expansion joint sealant will be measured by the linear meter (linear foot).

Elastomeric bearing pads will be measured by the each.

Groove concrete deck slab will be measured by the square meter (square yard).

Bridge deck curing compound will be measured by the liter (gallon).

BASIS OF PAYMENT

**502.05.01 Payment.** The accepted quantities, measured as provided above, will be paid for at the contract price per unit of measurement for the pay items listed below that are shown in the proposal. Payment will be full compensation for the work prescribed in this Section.

The headwalls to be cast-in-place at the end of the precast concrete box culverts will be measured and paid for under the appropriate items of work.

Payment will be made under:

| **Pay Item** | **Pay Unit** |
|---|---|
| (class) Concrete (Major) | Cubic Meter (Cubic Yard) |
| (class) Concrete (Minor) | Cubic Meter (Cubic Yard) |
| (class) Concrete, Modified (Major) | Cubic Meter (Cubic Yard) |
| (class) Concrete, Modified (Minor) | Cubic Meter (Cubic Yard) |
| (class) Concrete (Island Paving) | Cubic Meter (Cubic Yard) |
| Tremie Seal Concrete | Cubic Meter (Cubic Yard) |
| Fine Surface Finish | Square Meter (Square Yard) |
| Concrete Barrier Rail (type) | Linear Meter (Linear Foot) |
| Portable Precast Concrete Barrier Rail | Linear Meter (Linear Foot) |
| Portable Precast Concrete Barrier Rail (State-Furnished) | Linear Meter (Linear Foot) |
| Concrete Bridge Deck Repair | Force Account |
| Precast Concrete Box Culvert (size) | Linear Meter (Linear Foot) |
| Compression Joint Seal | Linear Meter (Linear Foot) |
| Strip Seal Expansion Joint (movement) | Linear Meter (Linear Foot) |
| Preformed Joint Filler (size) | Linear Meter (Linear Foot) |
| Asphaltic Plug Expansion Joint | Linear Meter (Linear Foot) |
| Expansion Joint (Special) | Linear Meter (Linear Foot) |
| Expansion Joint Sealant | Linear Meter (Linear Foot) |
| (type) Elastomeric Bearing Pads | Each |
| Groove Concrete Deck Slab | Square Meter (Square Yard) |
| Bridge Deck Curing Compound | Liter (Gallon) |

# SECTION 503

## PRESTRESSED CONCRETE AND PRECAST MEMBERS

DESCRIPTION

**503.01.01 General.** This work consists of furnishing and installing prestressing and post-tensioning systems and other items necessary for the particular prestressing system used, including but not limited to ducts, anchorage assemblies, and local zone reinforcement in precast concrete members or cast-in-place concrete members.

This work also consists of furnishing and placing either precast reinforced concrete members or precast prestressed concrete members as indicated on the plans.

Where reference is made herein to the “pretensioning method,” the prestressing steel strands or bars are assumed to be tensioned in a casting bed prior to placing concrete in the forms. Where reference is made herein to the “post-tensioning method,” the prestressing steel strands or bars are assumed to be tensioned in ducts after the concrete has been placed and has obtained the specified strength.

Furnish all components of a post-tensioning system from a single supplier. Prestressing steel can be obtained from any supplier as long as all prestressing steel in a tendon is from one supplier.

Furnish and place complete precast prestressed concrete and precast concrete members including all concrete, prestressing steel and items appurtenant to the pretensioning method used, reinforcing steel, and incidental materials in connection therewith.

Install prestressing steel, which may be strands or bars, in the concrete. Stress to a predetermined load. Where post-tensioning is used, grout ducts to fill all voids and install protection at end anchorages.

**503.01.02 Precast Plant Certification.** Produce all precast prestressed concrete members in a fabrication plant certified by the Precast/Prestressed Concrete Institute (PCI), unless otherwise approved in writing. The fabrication plant shall have a B3 or B4 Certification as required for the members being produced, unless otherwise approved in writing. Portable pretensioning beds will not be allowed.

Submit a copy of the fabrication plant’s PCI Certification and most recent PCI plant audit report before or along with the first submittal of shop drawings.

**503.01.03 Personnel Certifications.** Provide project personnel meeting the requirements of this Subsection.

For precast concrete plant facility Quality Control (QC), provide an on-site production manager, an on-site Facility Manager for QC, a plant engineer, and on-site QC inspectors/technicians to provide complete QC inspections and testing. Ensure the Facility Manager for QC has at least five years of related experience and a current Precast/Prestressed Institute (PCI) QC personnel Level III certification. Ensure that the QC inspector/technician has current PCI QC Technician/Inspector Level II certification. Submit copies of personnel certifications and qualifications for approval with the precast member shop drawings.

Perform all post-tensioning field operations under the direct supervision of a technician certified as a Level 2 Bonded PT Field Specialist through the Post-Tensioning Institute (PTI). Provide the name of the technician and furnish proof of certification with the prestressing working drawings.

Provide an individual certified as either a Certified Grouting Technician through the American Segmental Bridge Institute (ASBI) or a PTI Level 2 Bonded PT Field Specialist to supervise, inspect, and document the entire grouting operation. Provide close observation and control of all grouting operations by the certified technician. Have the certified technician on-site at any time when grouting is taking place. Provide the name of the grouting technician and furnish proof of certification with the Grouting Operations Plan.

MATERIALS

**503.02.01 General.** Material shall conform to the following Sections and Subsection:

Portland Cement Concrete ..... Section 501
Concrete Structures ..... Section 502
Reinforcing Steel ..... Section 505
Prestressing Steel ..... Subsection 713.03.03

**503.02.02 Tendon Grout.** Provide a commercial, prepackaged, tendon grout for grouting post-tensioning ducts. Deliver grout in moisture proof plastic lined or coated bags. Provide bags with manufacturer's labels showing brand name, intended application, date of manufacture, expiration date, lot number, and mixing and pumping instructions. Use grout within six months of the manufacture date.

Tendon grout shall conform to the requirements for a Class C grout, as defined by the Post-Tensioning Institute (PTI) Specification for Grouting of Post-Tensioned Structures and shall meet the vertical rise requirements for the project tendons.

Tendon grout shall not contain aluminum powder, gas generating components that produce hydrogen gas, carbon dioxide, or oxygen, expansive admixtures, or admixtures containing chloride.

Submit certified mill test reports for the tendon grout upon request. Tendon grouts will be approved based on prequalification testing. Perform testing by an independent certified testing facility. Test tendon grout at normal laboratory temperatures of 18 to 25 °C (65 to 78 °F) unless otherwise specified by the referenced test method. Re-qualify tendon grout for any changes made to either the source or type of all ingredients of the tendon grout.

Testing conducted for other state transportation agencies may be accepted as prequalification testing provided the test requirements herein are satisfied. For findings and evaluations of other state Departments of Transportation see the AASHTO Product Evaluation Listing Service.

Submit evidence that the grout manufacturer has an on-going quality control program for the tendon grout it produces. Evidence may include, but is not limited to, quality control data sheets, or recent test results for the proposed tendon grout. Test results shall be dated within one year of the intended grouting of the tendons.

Tendon grout shall conform to the following:

| TEST | TEST METHOD | REQUIREMENT |
|---|---|---|
| Strength | ASTM C942 | 21 MPa (3,000 psi) minimum @ 7 days<br>35 MPa (5,000 psi) minimum @ 28 days |
| Initial Set | ASTM C953 | 3 hr minimum, 12 hr maximum |
| Permeability | ASTM C1202 as modified by Section 4.4.3 of PTI* | Less than 2,500 coulombs after 6 hours using 30 volts on 28 day grout |
| Volume Change | ASTM C1090 | Vertical height change between 0.0% and + 0.1% @ 24 hours<br>Vertical height change of + 0.2% maximum @ 28 days |
| Fluidity | For thixotropic grouts, ASTM C939 as modified by Section 4.4.5.2 of PTI*<br>For non-thixotropic grouts, ASTM C939<br>After either test above, let sample stand for 30 minutes without further agitation, remix for 30 seconds, then test immediately | Efflux time between 5 and 30 seconds for a 1 liter discharge immediately after mixing<br>Efflux time between 11 and 30 seconds immediately after mixing<br>For thixotropic grout, efflux time of 30 seconds maximum for a 1 liter discharge<br>For non-thixotropic grout, efflux time of 30 seconds maximum |
| Wick Bleed | Wick Induced Bleed ASTM C940 as modified by Section C4.4.6.1 of PTI* | 0.0% maximum at 3 hours @ 20 °C (70 °F) |
| Pressure Bleed | Schupack Pressure Bleed (Gelman Pressure) in accordance with Appendix C of PTI* | 4% max at 20 psi with vertical rise between 0 to 0.6 m (0 to 2 ft)<br>2% max at 30 psi with vertical rise between 0.6 to 1.8 m (2 to 6 ft)<br>0% max at 50 psi with vertical rise between 1.8 to 30.5 m (6 to 100 ft) |
| Chloride Ions | ASTM C1152 | Less than 0.08% by mass of cementitious material |
| Fine Aggregate | ASTM C136 | 99% passing the 300 µm (No. 50) sieve |

* PTI Specifications for Grouting of Post-Tensioned Structures.
* Use ASTM C117 procedure modified to use a No. 50 sieve. Determine the percent passing the No. 50 sieve after washing the sieve.

Water for mixing grout shall have less than 500 ppm of chloride ions and no organic materials. Water with a pH less than 4.5 or greater than 8.5 and a resistivity less than 500 ohm•cm will be tested according to AASHTO T26. Any indication of unsoundness, marked change in time of setting, or a reduction of more than 10% in strength from results obtained with grout mixtures containing the water of satisfactory quality shall be sufficient cause for rejection of the water under tests.

**503.02.03 Nonshrink Grout.** Provide grout that is a non-metallic, non-metal oxidizing, and non-gas-liberating flowable fluid containing natural aggregate, Portland cement and additives and requiring only the addition of water. Provide a minimum of 385 kg of cement per cubic meter (650 lb of cement per cubic yard) nonshrink grout. Provide premeasured and prepackaged grout by the manufacturer, that is suitable for baseplate and foundation grouting. Show no aggregate segregation or settlement at fluid consistency at specified times or temperatures. Grout shall pass through a flow cone with continuous flow one hour after mixing.

Provide nonshrink grout conforming to the requirements of ASTM C1107, and the following additional requirements:

| PROPERTY | TEST METHOD | REQUIREMENT |
|---|---|---|
| Shrinkage | ASTM C827 | 0.0% |
| Expansion | ASTM C827 | 0.0% minimum, 4.0% maximum |
| Fluid Consistency | USACE CRD-C611/ASTM C939 | 20-30 seconds at 4-38 °C (40-100 °F) |
| 1-day Compressive Strength | ASTM C109 | 24.1 MPa (3500 psi) minimum |
| 3-day Compressive Strength | ASTM C109 | 31.0 MPa (4500 psi) minimum |
| 28-day Compressive Strength | ASTM C109 | 51.7 MPa (7500 psi) minimum |
| Chloride Content | ASTM C1152 | 0.24 kg/m$^3$ (0.40 lb/yd$^3$) maximum |

Grout shall have a minimum initial set time of 4 hours and minimum final set time of 6 hours at 21 °C (70 °F). Prior to use, store materials in suitable moisture resistant containers in a cool and dry environment. Label containers clearly with manufacturer's recommendations, limitations and cautions. Do not use broken or open packages. Provide grout with low levels of chlorides as specified above and free from other corrosion-causing chemicals. Design nonshrink grout for an air content of 4 to 6 percent.

Mix, place, and cure grout in accordance with the manufacturer's requirements, these specifications, and as approved.

Provide mix water conforming to the requirements of Subsection 503.02.02. Use cold water in hot weather conditions to maintain the mixed grout temperature from 7 to 32 °C (45 to 90 °F).

Use a quantity of water to be blended with the dry component within the limits recommended by the manufacturer. Use the least amount of water required to produce a flowable or fluid batter as required for the application, and as approved.

Submit for approval, specific printed manufacturer's product data including recommended preparation, placement and curing methods for each nonshrink grout application. Nonshrink properties shall not be based on gas or gypsum expansion.

## CONSTRUCTION

**503.03.01 General.** Perform prestressing by either (a) pretensioning methods, or (b) post-tensioning methods. If the plans show details for only one particular method, the use of the alternate method will be allowed only upon approval. If use of the alternate method is approved, submit complete details and design calculations for the alternate and for any other necessary modifications to the member for approval. Details and design calculations for approved alternate methods shall be stamped by an engineer who is registered as a Civil or Structural Engineer in the State of Nevada. Do not commence work until details and design calculations are approved in writing.

Submit working drawings according to Subsection 105.02, giving complete details and substantiating calculations of the method, materials, and equipment proposed for use in the construction, prestressing, and/or erection operations. Outline in such details the method of prestressing, and include the arrangement of the prestressing steel and mild steel reinforcement in the member (including grillage reinforcing designated in the Standard Plans), any additions or rearrangement of reinforcing steel, any revision in concrete dimensions from that shown on the plans, and working stresses. Submit complete, independent working drawings for each structure, working drawings shall not refer to drawings submitted for other structures.

For the pretensioning method, show on the shop drawings a sequence for cutting or releasing the prestressing steel. Include details and calculations for lifting embedments and lifting locations; methods of handling, storage, and transport. Provide a sequence of casting indicating when forms will be stripped, strands cut, and beams removed from the bed. Indicate the decision process for each action in the casting sequence. Do not start fabrication of any precast prestressed concrete member until shop drawings have been approved, written notice of the start of fabrication has been provided, and a pre-fabrication meeting has been completed.

For the post-tensioning method also include on the working drawings the specifications and details of anchoring devices and distribution plates or assemblies, calculated stresses in the anchorages and distribution plates, type of post-tensioning enclosures, sequence of stressing prestressing steel, pressure grouting materials and equipment, including all inlets, outlets, drains, permanent grout caps, direction of grouting and a method of detensioning the prestressing steel should it become necessary to do so before grouting takes place. The working drawings shall

also include results of post-tensioning anchorage system prequalification testing according to Subsection 503.03.04 and a grouting operations plan according to Subsection 503.03.07.

Do not use or install prestressing steel in the work until the prestressing steel has been sampled, tested and approved for use.

When requested, submit drawings of forms proposed for the precast concrete members according to Subsection 105.02. Show in such drawings the complete details of the type of forms proposed for providing any indicated openings and proposed method of supporting and anchoring such forms.

If electing to prestress precast concrete members and a prestressed option is not shown on the plans, design the members as precast prestressed members and the design calculations and drawings according to Subsection 105.02. Design calculations and drawings shall be stamped by an engineer who is registered as a Civil or Structural Engineer in the State of Nevada. Do not commence work until details and design calculations are approved in writing.

Give notice in writing 14 days in advance of performing prestressing operations.

**503.03.02 Protection of Materials.** Store and protect all prestressing materials in a weatherproof enclosure until time of use. Protect all prestressing steel against physical damage, rust, and other results of corrosion at all times from manufacture to grouting or encasing in concrete. Prestressing steel that has sustained physical damage will be rejected. The development of visible rust or other results of corrosion will be cause for rejection.

Package prestressing steel in containers or shipping forms for the protection of the steel against physical damage and corrosion during shipping and storage. Place a corrosion inhibitor which prevents rust or other results of corrosion in the package or form, or incorporate in a corrosion inhibitor carrier type packaging material, or when permitted, apply directly to the steel. The corrosion inhibitor shall have no deleterious effect on the steel or concrete or bond strength of steel to concrete. Immediately replace or restore packaging or forms damaged from any cause to original condition.

Clearly mark the shipping package or form with a statement that the package contains high-strength prestressing steel, the care to be used in handling, and the type, kind and amount of corrosion inhibitor used, including the date when placed, safety orders and instruction for use.

Do not weld reinforcing or prestressing steel. Any weldments to reinforcing or prestressing steel shall be subject to rejection. Replace any reinforcing or prestressing steel rejected by the Engineer.

Make no welds or grounds for welding equipment on the forms or on the steel in the member after the prestressing steel has been installed.

If prestressing steel for pretensioning is placed in the stressing bed and exposed to the elements for more than 36 hours before encasement in concrete, take acceptable measures to protect said steel from contamination or corrosion.

If prestressing steel for post-tensioning is installed in members prior to the placement of concrete, such as strand in flat ducts, continuously protect prestressing steel against rust or other corrosion, until grouted, by means of a corrosion inhibitor placed in the ducts or applied to the steel in the duct. Provide a vapor phase corrosion inhibitor formulated for use in protecting prestressing steel in ungrouted tendons that does not contain silicates, phosphates, nitrates or heavy metals, that provides up to 24 months of continuous protection using a monomolecular inhibiting layer and which does not affect the physical properties of the concrete or grout. Submit brand name, MSDS, product instructions and evidence of past successful use on other projects for approval.

When prestressing steel for post-tensioning is installed in the ducts after completion of concrete curing, and if stressing and grouting are completed within 10 days after the protective packaging has been opened, rust which may form during said 10 days will not be cause for rejection of the steel. The use of a corrosion inhibitor in the duct following installation of the prestressing steel within the above 10 days, will not be required except when requested because of adverse weather conditions. Prestressing steel installed as above but not grouted within 10 days shall be subject to all the requirements in this Subsection pertaining to corrosion protection and rejection due to rust.

When steam curing is used, do not install prestressing steel for post-tensioning until the steam curing is completed.

Ship ducts for prestressing steel in bundles which are covered during shipping and storage. Protect ducts against crushing, excessive bending, dirt contamination and corrosive elements during transportation, storage and handling. Do not remove covering supplied with the ducts until the ducts are incorporated into the bridge component. Store ducts on a raised platform and completely covered to prevent contamination. If necessary, wash ducts before use to remove contamination.

Use water for flushing ducts containing either quick lime (calcium oxide) or slaked lime (calcium hydroxide) in the amount of 12 g/L (0.10 lb/gal). Use oil free compressed air to blow out ducts.

Store tendon grout in waterproof enclosures maintaining temperatures within the range recommended by the manufacturer. Do not open packaging until time of mixing. Bags or bulk containers that are damaged or previously opened will be rejected.

**503.03.03 Forms.** Do not deposit concrete in the forms until after inspection of reinforcement, anchorages, ducts, inlet and outlet pipes, embedments, and/or prestressing steel. Deposit concrete in forms that have a minimum temperature of 5 °C (41 °F) and are within 17 °C (30 °F) of the temperature of the concrete at the time of placement.

Vibrate the concrete internally or externally, or both, as required to consolidate the concrete. Vibrate with care and in such a manner to not displace reinforcement, ducts, anchorages, embedments and/or prestressing steel.

Construct forms for interior cells or holes in the members of a material that will resist breakage or deformation during the placing of concrete and will not materially increase the mass of the member. “Lost forms,” left in place in interior cells, shall not exceed 575 $N/m^2$ (12 $lb/ft^2$) of supported deck area.

Provide access through forms to locations where operations for duct pressure testing and grouting operations will be performed.

Side forms for prestressed members may be removed the day after placing concrete therein, provided satisfactory arrangements are made for curing and protecting the concrete. Remove all side forms before releasing pretensioned prestressing steel and before tensioning post-tensioned prestressing steel. Remove side forms of precast pretensioned members after the concrete has reached the compressive strength shown on the plans or a minimum of 21 MPa (3,000 psi). Remove side forms prior to cooling when accelerated curing methods are used.

For precast members, provide holes for anchor bars, and for diaphragm dowels which pass through the member, openings for connection rods, recesses for grout, and any other holes and recesses as necessary in the members according to the details shown on the plans or the approved working drawings. Where diaphragm dowels do not pass through the member, the dowels may be anchored in the member by embedment in the concrete or by means of an approved threaded insert.

Lifting anchors may be installed in precast members provided any portion of the anchor extending beyond the precast member is removed after the member is placed.

**503.03.04 Anchorages and Distribution.** Secure all post-tensioned prestressing steel at the ends by means of approved permanent type anchoring devices.

Post-tensioning anchorage systems will be approved based on prequalification testing. Conduct prequalification testing by an independent testing laboratory which certifies that the complete tendon anchorage system meets the requirements of Subsection 10.3.2.3 of the AASHTO LRFD Bridge Construction Specifications. Testing conducted for other state transportation agencies may be accepted as prequalification testing. Submit documentation of anchorage system prequalification with the working drawings for approval. Include the following information in the submittal:

1. Dimensions of the test specimen.
2. Drawings and dimensions of the anchorage device, including all confining reinforcing steel.
3. Amount and arrangement of supplementary skin reinforcement.
4. Type and yield strength of reinforcing steel.
5. Type and compressive strength at time of testing of concrete.
6. Type of testing procedure and all recorded measurements.

Ensure all anchorage devices for post-tensioning hold the prestressing steel, when tested in an unbonded state, at a load producing a stress of not less than 96% of the actual ultimate tensile strength of the prestressing steel without exceeding the anticipated set.

Design anchorages so that the average concrete bearing stress is in compliance with the AASHTO LRFD Bridge Design Specifications. Use materials and workmanship conforming to Section 506.

Approved anchorage devices are designed and provided by the anchorage manufacturer and typically include a trumpet, anchor plate, anchor head with seating wedges, and confining reinforcement located directly behind the anchor head (referred to as local zone reinforcement). Provide local zone reinforcement at all anchorages according to the approved prequalification testing drawings. Also provide supplemental grillage reinforcing as indicated in the contract documents.

Provide wedge plates with centering lugs or shoulders to facilitate alignment with the bearing plate.

Cast anchorages with grout outlets suitable for inspection from either the top or front of the anchorage. The grout outlet will serve a dual function of grout outlet and post-grouting inspection access. The geometry of the grout outlets must facilitate being drilled using a 9.5 mm (3/8 in.) diameter straight bit to facilitate endoscope inspection directly behind the anchor plate. Anchorages may be fabricated to facilitate both inspection locations or may be two separate anchorages of the same type each providing singular inspection entry locations.

Trumpets associated with anchorages shall be made of either ferrous metal or polypropylene plastic material. The thickness of the trumpet at the transition location (choke point) shall not be less than the thickness of the duct. Alternately, the trumpet material may be polyolefin containing antioxidants with a minimum Oxidation Induction Time (OIT) according to ASTM D3895 of not less than 20 minutes. Perform OIT test on samples taken from the finished product. Test the remolded finished polyolefin material for stress crack resistance using ASTM F2136 at an applied stress of 2.4 MPa (348 psi) resulting in a minimum failure time of 3 hours.

Epoxy coat any additional reinforcing at anchorages, including added spirals or grillages, located within 300 mm (12 in.) of the driving surface where the contract documents call for epoxy coating of the deck steel. For such bars where only a portion of the bar is within 300 mm (12 in.) of the driving surface, epoxy coat the whole bar. Galvanize any anchorage where any portion of the anchorage is within 300 mm (12 in.) of the driving surface. Galvanize according to Section 715.

If loop tendon anchorages are used, enclose them in ducts for their entire length.

Equip all anchorages with a permanent grout cap that is vented and bolted to the anchorage. Where the end of a post-tensioned assembly will not be covered by concrete, recess the anchoring devices so that the ends of the prestressing steel and all parts of the anchoring devices, including grout caps, will be at least 50 mm (2 in.) inside of the end surfaces of the members, unless a greater embedment is shown on the plans. Following post-tensioning, fill the recesses with non-shrink grout and finish flush.

Use permanent grout caps made from fiber reinforced polymer or ASTM A240 Type 316L stainless steel. The resins used in the fiber reinforced polymer shall be nylon, Acrylonitrite Butadiene Styrene (ABS) or polyester. For products made from nylon, the cell class of the nylon according to ASTM D5989 shall be S-PA0141 (weather resistant), S-PA0231 or S-PA0401 (ultimate strength not less than 69 MPa (10,000 psi) with UV stabilizer added). Seal the cap with “0” ring seals or precision fined flat gaskets placed against the bearing plate. Place 13 mm (1/2 in.) minimum grout vent on the top of the cap. Grout caps shall be rated for a minimum pressure rating of 1.03 MPa (150 psi). Use ASTM A240 Type 316L stainless steel bolts to attach the cap to the anchorage. When stainless steel grout caps are supplied, provide certified test reports documenting the chemical analysis of the steel. Submit material certifications and test reports with the working drawings.

**503.03.05 Ducts.** Provide and accurately place duct enclosures for prestressing steel of mortar-tight rigid galvanized ferrous metal. Ensure that all connectors, connections, and components of post-tensioning system hardware are rated for the minimum pressure requirements herein.

Ducts for prestressing steel made up of a single wire, bar or strand, shall have a minimum inside diameter 13 mm (1/2 in.) larger than the diameter of the wire, bar, strand, or couplers to be used. For tendons made up of a plurality of wires, bars, or strands, the duct area shall be at least 2.5 times the gross area of the prestressing steel.

Use rigid ducts with either welded or interlocked seams. Galvanizing of the welded seam will not be required. Provide ducts of sufficient strength to maintain their correct alignment during placing of concrete. Use positive metallic connections between sections which do not result in angle changes of the joints. Use waterproof tape at the connections. Bend ducts without crimping or flattening. Transition couplings connecting ducts to anchoring devices need not be galvanized. Construct tendons using a minimum number of duct splices.

Accurately align ducts and position at the locations shown on the plans and according to the approved shop drawings or as otherwise directed. The center of gravity of the prestressing force shall not vary from girder to girder unless noted in the plans or approved shop drawings. Securely fasten all internal ducts in position as necessary to maintain accurate duct placement during concreting and at regular intervals not exceeding 610 mm (24 in.) for round galvanized duct and 300 mm (12 in.) for flat ducts to prevent movement, displacement or damage from concrete placement and consolidation operations. Show the method and spacing of duct supports on the shop drawings. Use mandrels as needed to maintain duct alignment and shape. Place ducts providing a smooth and continuous alignment with no lips, kinks, or dents. Provide smooth transitions in duct joints without any kinks. Do not exceed angle changes by more than ± 3 degrees in any direction.

Install post-tensioning ducts to within the following tolerances:

| Application | Vertical Position mm (in.) | Lateral Position mm (in.) |
|---|---|---|
| Horizontal tendons in slabs or in slab regions of larger members | ± 6 (1/4) | ± 13 (1/2) |
| Longitudinal draped super-structure tendons in webs:<br>Tendon over supports or in middle third of span<br>Tendon in middle half of web depth | <br>± 6 (1/4)<br>± 13 (1/2) | <br>± 6 (1/4)<br>± 6 (1/4) |
| Longitudinal, generally horizontal, superstructure tendons in top or bottom of member | ± 6 (1/4) | ± 6 (/4) |
| Horizontal tendons in substructures and foundations | ± 13 (1/2) | ± 13 (1/2) |
| **Application** | **Longitudinal Position mm (in.)** | **Transverse Position mm (in.)** |
| Vertical tendons in webs | ± 25 (1) | ± 6 (1/4) |
| Vertical tendons in pier shafts | ± 13 (1/2) | ± 6 (1/4) |

Construct ends of tendon anchorage entrance and exit angles to within ± 3 degrees of the angle shown on the approved shop drawings when measured in any direction. Provide smooth transitions without any kinks or deviations in the alignment.

Locate anchorages within ± 6 mm (1/4 in.) of desired position laterally and ± 25 mm (1 in.) along the tendon except that minimum cover requirements shall be maintained.

Position anchorage confinement reinforcing steel as shown on the approved shop drawings in the form of spirals, multiple U shaped bars or links, to be properly centered around the duct and to start within 13 mm (1/2 in.) of the back of the main anchor plate.

In the event of conflicts between the reinforcing steel and post-tensioning duct, the position of the post-tensioning duct shall prevail with the reinforcing steel adjusted locally as approved.

Carefully check and repair all ducts as necessary before placing concrete. Use methods to place and consolidate concrete which will not displace or damage post-tensioning ducts, anchorage assemblies, splices and connections, reinforcement, or other embedments. Fabricate duct splices to prevent duct kinks during concrete placement. Use mandrels as needed to maintain duct alignment and shape.

Plug all tendons except preloaded ducts at the anchorages with plumbing type expanding compression plugs at the time the anchorages are attached to the forms and before concrete placement. Maintain plugs in place until after curing is completed and the ducts are ready for pressure testing prior to strand installation.

Place grout inlets and outlets at locations as shown on the plans and working drawings. At a minimum, place grout inlets and outlets in the following positions:

1. Top of the tendon anchorage.
2. Top of the grout cap.
3. At high points of duct when vertical distance between highest and lowest point is more than 0.5 m (20 in.).
4. At a location 1.0 m (3 ft) past high points of the duct in the direction of grouting.
5. At all low points.
6. At major changes in the cross section of the duct.
7. At additional locations as directed.

At high points and 1.0 m (3 ft) past high points, provide a minimum length inlet and outlet above the deck surface of 1.5 m (5 ft) plus 0.3 m (1 ft) for each 10 m (30 ft) of duct between the adjacent low points.

Mark all inlets and outlets not located at anchorages with a tag indicating the tendon number and vent number for identification during grouting.

Provide permanent grout inlets, outlets, and threaded plugs made of ASTM A240 Type 316 stainless steel, nylon, or polyolefin materials. For products made from nylon, the cell class of the nylon according to ASTM D5989 shall be S-PA0141 (weather resistant), S-PA0231 or S-PA0401 (ultimate strength not less than 69 MPa (10,000 psi) with UV stabilizer added). Products made from polyolefin shall contain antioxidants with a minimum Oxidation Induction Time according to ASTM D3895 of not less than 20 minutes. Test the remolded finished polyolefin material for stress crack resistance using ASTM F2136 at an applied stress of 2.4 MPa (348 psi) resulting in a minimum failure time of 3 hours. Equip inlets and outlets with pressure rated mechanical shut-off valves or plugs rated for a minimum pressure of 1.03 MPa (150 psi). Use inlets and outlets with a minimum inside diameter of 20 mm (3/4 in.) for multi-strand systems and 13 mm (1/2 in.) for single bar tendons and four-strand duct with lengths of less than 30 m (100 ft). Specifically designate temporary items, not part of the permanent structure, on the working drawings. Temporary items may be made of any suitable material.

The diameter of the opening in the duct for installation of the grout inlets and outlets shall be equal to the inside diameter of the inlets and outlets.

After installing ducts and before concrete placement, seal the ends of all ducts, connections to anchorages, splices, inlets and outlets until grouting is complete. Provide an absolute seal of anchorage and duct termination locations by using plumbing type expanding compression plugs or equal. Maintain plugs in place until after curing is completed and the ducts are ready for pressure testing. Grout inlets and outlets shall be installed with plugs or valves in the closed position. Leave low point outlets open.

After completion of concrete curing, prove that the post-tensioning ducts are free and clear of any obstructions or damage and are able to accept the intended post-tensioning tendons by passing a torpedo through the ducts. Use a torpedo having the same cross-sectional shape as the duct that is 6 mm (1/4 in.) smaller all around than the clear nominal inside dimensions of the duct, and has rounded ends. Make no deductions to the torpedo section dimensions for tolerances allowed in the manufacture or fixing of the ducts. For straight ducts, use a torpedo at least 0.6 m (2 ft) long. For sharply curved ducts, determine the length so that when both ends touch the outermost wall of the duct, the torpedo is 6 mm (1/4 in.) clear of the innermost wall. If the torpedo will not travel completely through the duct, the member will be rejected. A rejected member may be accepted if a workable repair can be made to clear the duct or it is demonstrated that the equivalent cross sectional area of an undamaged duct is provided and all required strand can be loaded into the duct.

**503.03.06 Prestressing.** Furnish and install prestressing steel and tension by means of hydraulic jacks so that the force in the prestressing steel is not less than the value shown on the plans.

For post-tensioning of cast-in-place members, distribute the prestressing steel so that the force in each girder stem is equal as required by the plans, or as provided herein. For box girders with more than 2 girder stems, the prestressing force may vary up to 5% from the theoretical required force per girder stem provided the required total force in the superstructure is obtained and the force is distributed symmetrically about the centerline of the cross section.

Distribute the prestressing steel so that the center of gravity of the prestressing tendon path in each girder stem matches the path shown on the plans.

Do not install strand into ducts until the curing of the deck is complete, unless flat ducts require installation prior to concrete placement.

Push or pull prestressing strands through the ducts to make up a tendon using methods which will not snag on any lips or joints in the ducts. When strands are pushed, round their ends or fit them with a smooth protective cap. Do not use mechanical devices to rotate strand during the installation into the duct. Alternatively, strands may be assembled to form the tendon and pulled through the duct using a special steel wire sock or other device attached to the end. Do not weld strand together. Round the end of the pre-assembled tendon for smooth passage through the duct. Cut strands using an abrasive saw or equal. Flame cutting is not allowed.

Suspend or support strand during loading so that it does not come in contact with the ground. Where strands are pulled in and must be assembled outside the tendon, provide raised platforms, tarps or other means to prevent dirt and dust contamination of the strands.

Do not post-tension cast-in-place and precast concrete until at least 10 days after the last concrete has been placed in the member and until the compressive strength of concrete has reached the strength required on the plans and shop drawings. Compressive strength shall be determined by cylinder tests. Conduct all stressing operations in the presence of the Engineer.

After stressing, do not cut exposed strand until the elongations are approved.

Do not cut or release prestressing steel in any pretensioned member until the concrete has attained the minimum compressive strength value specified for releasing of the steel.

Tension prestressing steel to an initial force of 20% of the jacking force, unless shown otherwise on the plans or approved shop drawings. After initial tensioning, apply final jacking force to prestressing steel and measure elongation.

Do not allow the temporary tensile stress (jacking stress) to exceed 80% of the specified minimum ultimate tensile strength of the prestressing steel. Do not overstress tendons to achieve the expected elongation. Anchor prestressing steel at stresses (initial stress) that will result in the ultimate retention of permanent stresses or forces of not less than those shown on the plans. Do not allow the initial stress at the anchorages to exceed 70% of the specified minimum ultimate tensile strength of the prestressing steel. Limit the initial stress in the prestressing steel at all locations along the tendon except at the anchorages to 74% of the specified ultimate tensile strength.

Working force and working stress will be considered as the force and stress remaining in the prestressing steel after all losses, including creep and shrinkage of concrete, elastic compression of concrete, creep of steel, losses in post-tensioned prestressing steel due to sequence of stressing, friction and take up of anchorages, and all other losses peculiar to the method or system of prestressing have taken place or have been provided for.

The loss in stress in post-tensioned or pretensioned prestressing steel due to creep and shrinkage of concrete, creep of steel, sequence of stressing, and elastic compression of concrete shall be as indicated on the plans. Determine losses particular to the chosen method or system of prestressing such as sequence of stressing or friction and take up of anchorage and include in submittal of substantiating calculations for review. Prepare substantiating calculations in accordance with the bridge design specifications and design parameters as indicated on the plans.

Compensate for the loss of prestress in pretensioned members due to the temperature of prestressing steel being appreciably lower than the estimated temperature of the concrete by increasing the calculated elongation. Take into account the loss of prestress in the total forces in the prestressing steel, but do not exceed a jacking stress of 80% of the specified minimum ultimate tensile strength of the prestressing steel.

Only use jacking equipment furnished by the supplier of post-tensioning system (tendons, hardware, anchorages, etc.).

If power seating stressing equipment is used to reduce losses due to anchor set, submit certified test results showing the amount of seating loss that can be consistently achieved.

Equip each jack used to stress tendons with either a pressure gage or a load cell for determining the jacking stress. Provide pressure gage, if used, with an accurately reading dial at least 150 mm (6 in.) in diameter. Calibrate each jack and its gage as a unit with the cylinder extension in the approximate position that it will be at final jacking force, and accompany with a certified calibration chart. Provide calibrated load cell, if used, with an indicator by means of which the prestressing force in the tendon may be determined. Do not use the lower 10% of the manufacturer's rated capacity of the load cell in determining the jacking stress.

Calibrate each jack and its gages as a unit. The calibration shall consist of three test cycles with the cylinder extension of the jack in various positions including the approximate cylinder position expected at the final jacking force [i.e. 50 mm (2 in.), 100 mm (4 in.), 200 mm (8 in.), etc strokes]. At each pressure increment, average the forces from each test cycle to obtain an average force. Perform the calibration with the equipment (jack, pump, hoses, etc.) setup in the same configuration that is intended to be used at the job site. The post-tensioning supplier or an independent laboratory shall perform initial calibration of jacks and gages. Use load cells calibrated within the past 12 months to calibrate stressing equipment. For each jack and gage unit used on the project, furnish certified calibration charts and curves prior to stressing. For extended duration projects, furnish updated calibration charts and curves every 6 months, or as requested. Supply documentation denoting the load cells calibration date and traceability to NIST (National Institute of Standards and Technology) along with the jack/gage calibration.

Any hydraulic jack repair, such as replacing seals or changing the length of the hydraulic lines, is cause for recalibration using a load cell.

Provide a calibrated load cell, if used, with an indicator by means of which the prestressing force in the tendon may be determined.

The certified calibration charts for the hydraulic jacks, pressure gages, or load cells used for tensioning prestressing steel may be checked before and during tensioning operations with State-furnished load cells. Provide sufficient labor, equipment, and material to install and support the load cells at the prestressing tendons and to remove the load cells after the checking is complete, as ordered. The checking operations will be conducted by the Engineer.

Except as noted on the plans or the approved shop drawings, tension post-tensioning tendons from both ends. Apply the required force at one end and subsequently at the other end.

Where one end stressing is shown on the plans or approved shop drawings, and the stressing end is not indicated, tension one-half of the tendons from one end of the member and the other half from the opposite end.

For construction in stages where some tendons are required to be stressed before others, install and stress in accordance with the plans or approved shop drawings or as otherwise approved.

Conduct the tensioning process so that tension being applied and the elongation of the prestressing steel may be measured at all times. Mark the strand or provide a positive attachment to the strand so that slippage or uneven jack pull can be easily identified. Record gage pressures and elongations at all times while tensioning and submit for approval. Measure elongations to the nearest 1.5 mm (1/16 in.).

Stop stressing operations if the measured elongation at total tendon force is not within ± 5% of the calculated theoretical elongation or if similar tendons differ by more than ± 4%. Determine cause and do not restart stressing operations until corrective measures are approved. Do not exceed the total tendon force to achieve the calculated theoretical elongation.

When ordered, check prestressing steel in pretensioned members, if tensioned individually, for loss of prestress not more than 3 hours before placing concrete. The method and equipment for checking the loss of prestress will be subject to approval. Re-tension all tendons to the original intended jacking force which show a loss of prestress in excess of 3%.

Multi-strand post-tensioning tendons having wire or strand failures, by breaking or slippage during stressing, may be accepted at the discretion of the Engineer under the following conditions:

1. The completed structure shall have a final post-tensioning force of at least 98% of the design total post-tensioning force.
2. For precast or cast-in-place segmental construction or for similar construction that has members post-tensioned together across a common joint face, at any stage of erection, the post-tensioning force across a mating joint shall be at least 98% of the post-tensioning required for that mating joint for that stage of erection.
3. Any single tendon shall have no more than a 5% reduction in cross-sectional area of post-tensioning steel due to wire failure.

Investigate persistent wire breakage and change procedures or equipment to avoid or significantly reduce wire or strand failures. Remove and replace tendons in which an unacceptable level of wire or strand failures has occurred.

Maintain strand stress between anchorages in precast members until placement of concrete is complete and the concrete has reached the minimum compressive strength shown on the plans. Release prestressing steel in such an order that lateral eccentricity of applied prestressing force will be a minimum. Cut prestressing steel flush with the end of the member, unless otherwise shown on the plans, and coat exposed ends of the prestressing steel with an approved zinc-rich paint.

**503.03.07 Bonding and Grouting.** Bond post-tensioned prestressing steel by completely filling the entire void space in the duct with grout. Complete grouting each tendon within 14 days of placing the strand or bar into the duct. Fully tension all post-tensioning within the structure prior to any grouting operation.

When shown on the plans, debond pre-tensioned prestressing steel by encasing strands in plastic sheathing along the entire debonded length, and seal the ends with waterproof tape. Split plastic sheathing may be used provided the seam is sufficiently sealed with waterproof tape to prohibit concrete infiltration. Do not use sheathing that will permanently alter the physical or chemical properties of the surrounding concrete.

Full-length debonding of straight strands will only be allowed if designated on the approved working drawings. Full-length debonding, when permitted, shall be symmetrical about the vertical centerline of the beam and limited to 10% of the total number of straight strands or 6 straight strands, whichever is less. Do not debond draped strands full length.

(a) Grouting Operations Plan. Submit a Grouting Operations Plan for approval at least 30 days in advance of grouting operations. Written approval of the Grouting Operations Plan will be required before grouting of the permanent structure takes place. Address and provide procedures for the following:

1. Names and proof of training for the technicians who will be present in the field during grouting.
2. Type, quantity, and brand of materials used including all certifications required.
3. Type of equipment proposed, including capacity in relation to demand and working condition.
4. General grouting procedure.
5. Types and locations of inlets, outlets, vents and drains based on the intended grouting procedure.
6. Calculate of the maximum vertical rise of the grout within the tendon using the actual bridge geometry where the vertical rise is defined as the distance between the lowest and highest points within the tendon or the anchorages.
7. Duct cleaning and proofing equipment and methods, including torpedo dimensions.
8. Duct pressure test and repair procedures.
9. Method to be used to control the rate of flow within ducts.
10. Theoretical grout volume calculations for each typical duct.
11. Mixing and pumping procedures.
12. Direction of grouting.
13. Sequence of use of the inlets and outlet pipes.
14. Proposed forms for recording grouting information.
15. Procedures for handling blockages.

When more than one structure on a contract are being prestressed, the Contractor may submit only one Grouting Operations Plan if the operations are the same for all structures and the types and locations of all grout inlets, outlets, vents and drains, calculated maximum vertical rise of the grout, duct cleaning and proofing equipment and methods, direction of grouting and sequence of use of the inlets and outlet pipes are included on the prestressing working drawings for each structure.

Before grouting operations begin, conduct a joint meeting of the Contractor, grouting technician and Department personnel. At the meeting the Grouting Operations Plan, required testing, corrective procedures, and any other relevant issues will be discussed.

Resubmit the Grouting Operations Plan detailing proposed repair methods when grout voids are found.

(b) Tendon Grout Trial Batch. Within 48 hours of beginning grouting on a structure, mix a trial batch of grout using the equipment, materials, and proportions proposed for use. Mix a minimum of 150 L (40 gal) of grout. Dispose of excess grout not used for the trail batch testing according to Subsection 107.14.

Perform the following tests on the trial batch:

1. Fluidity. Determine the efflux time at 0 quiescent time according to ASTM C939 modified as follows:

   Fill the flow cone to the top of the cone. When thoroughly mixed, the efflux time of grout will be the time to fill a one liter container that is placed directly under the flow cone. Ensure the efflux time of the grout immediately after mixing is between 5 and 30 seconds. Let the grout stand in the collection container for 30 minutes without agitation then retest after remixing for 30 seconds using a handheld colloidal mixer. Ensure the efflux time of the grout immediately after remixing is 30 seconds or less.

2. Mud Balance. For a tendon grout that meets the required fluidity, determine a wet density value for mud balance comparative testing during grouting operations according to American Petroleum Institute Recommended Practice 13B-1. Use this mud balance value during production for acceptance, as specified herein.

3. Compressive Strength. For a tendon grout that meets the required fluidity, provide two sets of 3 cubes. Testing shall be performed in accordance with ASTM C109.

4. Simulated Field High Temperature Fluidity Test. Where air temperatures are expected to remain above 27 °C (80 °F) during tendon grouting and as directed, perform a high temperature grout fluidity test as described below using production grouting equipment utilizing both mixing and storage tanks. Tendon grouts shall conform to the requirements of these specifications including initial fluidity test. For the test to be successful, the tendon grout shall have an efflux time of not greater than 30 seconds at the end of the one hour test period. Determine efflux time by the modified ASTM C939 described herein.

   Perform the test in a temperature conditioned room. Condition the room, grout, water, duct, pump, mixer and all other equipment to be used to a temperature of 33 °C (90 °F) for a minimum of 12 hours prior to the test. Use 122 m (400 ft) of duct for the test. Use a duct with a nominal inside diameter of 25 mm (1 in.). Mix the tendon grout to the specified water content. Pump the grout through the duct until the grout discharges from the outlet end of the duct and is returned to the pump. Start the one-hour test period after the duct is completely filled with grout. Constantly pump and recirculate the grout into the commercial grout mixer storage tank. Pump and recirculate the grout for a minimum of one hour. Record, at 15-minute intervals throughout the test period, the pumping pressure at the inlet, grout temperature, and fluidity at the discharge outlet.

(c) Grouting Procedures and Equipment. Conduct pressure tests for all ducts prior to loading strand and after stressing is completed. Do not load strand or commence grouting until pressure tests are successful. Submit complete records of testing prior to loading strand or commencing grouting. Attach all grouting appurtenances such as valves and grout caps, inlets and outlets, and test the duct with oil free compressed air. Pressurize the duct to 207 kPa (30 psi) and lock-off the outside air source. Record pressure loss for one minute. If the pressure loss exceeds 103 kPa (15 psi), repair the duct using approved methods and retest. Do not apply air pressure to multiple ducts simultaneously without prior approval.

Provide accessory equipment that will accurately measure the amount of water being added to the mixer.

Provide watertight grout hoses, valves, and pipe fittings.

Mix prepackaged grout and water in accordance with the manufacturer’s written instructions.

Provide grouting equipment with separate motors or engines for the grout mixer, the holding tank, and the grout pump, and a system for controlling each independent of the other. Provide a secondary holding and agitating tank of approximately the same volume as the primary holding and agitating tank. Use high speed, high shear, colloidal grout mixers capable of continuous mixing that will produce a uniform thoroughly mixed grout, that is free of lumps and undispersed grout mix. Mix for such duration, as required by the grout manufacturer, to produce a uniformly blended grout.

Do not exceed the water content recommended by the grout manufacturer. Do not add additional water to improve the flowability of the grout. Continuously agitate grout until it is pumped.

Determine the fluidity of the grout in accordance with the test requirements of Subsection 503.02.02, at least once at the beginning of each days grouting, or at other times, and at a frequency as directed to verify flow characteristics remain within the tolerances specified. The grout sample for fluidity testing may be taken from a production batch of grout. Perform sampling after mixing either prior to entering the pump or at the outlet at the end of the tendon, as directed. The efflux time measured at the mixer, at any time during grouting, shall not be more than 5 seconds different from the efflux time at the mixer of the trial batch, and shall also be between 5 and 30 seconds. The efflux time of grout ejected from the vents shall not be more than 5 seconds different than the efflux time at the mixer.

Perform mud balance wet density testing on each batch of grout mixed. Compare and document the mud balance wet density with the value obtained during the trial batch, if the value differs by more than 3%, rerun ASTM C939, as modified in these specifications, for continued compliance.

Stop grouting if the proposed tendon grout does not produce acceptable fluidity or wet density. Do not restart grouting until the tendon grout product or manufacturer is changed and another trial batch is successful with a qualified tendon grout.

Use grouting equipment of a positive displacement type capable of maintaining a discharge pressure of at least 1.0 MPa (150 psi), but not more than 1.7 MPa (250 psi) at the tendon inlets. Provide a pump with adequate seals to prevent introduction of oil, air, or other foreign substance into the grout, and to prevent loss of grout or water. Use grouting equipment with gravity feed to the pump inlet from a hopper attached to and directly over it. Keep the hopper at least partially full of grout at all times during the pumping operation to prevent air from being drawn into the post-tensioning duct.

Furnish grouting equipment with a pressure gage having a full-scale reading of not more than 2.0 MPa (300 psi). The pressure gage shall be placed at the duct inlet such that the pressure in the duct can be read at all times even when not actively pumping grout. If hoses in excess of 30 m (100 ft) are used, use two gages, one at the pump and one at the inlet.

Thoroughly clean grouting equipment including mixers, holding tanks, and hoses at the end of each grouting stage or every 4 hours whichever occurs first.

Under normal conditions, the grouting equipment shall be able to continuously grout the longest tendon in less than 20 minutes. Pump grout within 30 minutes of the first addition of the mix components. Completely empty the grout mixer of grout into the pump or holding tank before mixing another batch of grout in the mixer.

Provide standby flushing equipment capable of developing a pressure of 1.7 MPa (250 psi) and of sufficient capacity to flush out any partially grouted ducts due to blockage or breakdown of equipment. Demonstrate that the standby system is accessible and operable should its use be required.

Clean and free ducts of deleterious materials that would impair bonding of the grout or interfere with grouting procedures. Blow out each duct with oil free air within one hour prior to grouting.

Pass grout through a screen with 3 mm (1/8 in.) maximum clear openings before introduction into the pump.

When hot weather conditions would contribute to quick stiffening of the grout, cool the grout or mix water by approved methods to prevent blockages during pumping operations.

Extend grout tubes a sufficient distance out of the concrete member to allow for proper closing of the valves.

Open all grout outlets before starting the grouting operation. Grout tendons in accordance with the Grouting Operations Plan.

Unless approved otherwise, pump grout at a rate of 5 to 15 m (16 to 50 ft) of duct per minute. Conduct normal grouting operations at a pressure range of 69 to 345 kPa (10 to 50 psi) measured at the grout inlet. Do not exceed the maximum pumping pressure of 1.0 MPa (150 psi) at the grout inlet.

Use grout pumping methods that will ensure complete filling of the ducts and complete encasement of the steel. Grout shall flow from the first and subsequent outlets until residual water or entrapped air has been removed prior to closing the outlet.

Pump grout through the duct and continuously discharge it at the anchorage and grout cap outlets until free water and air are discharged and the consistency of the grout is equivalent to that of the grout being pumped into the inlet. Close the anchorage outlet and discharge a minimum of 7.5 L (2 gal) of grout from the grout cap into a clean receptacle. Close the grout cap outlet.

After all outlets have been bled and sealed, elevate the grout pressure to approximately 345 kPa (50 psi), seal the inlet valve and wait two minutes to determine if any leaks exist. Note any pressure loss on the gage in-line with the duct. If leaks are present, fix the leaks using approved methods. Repeat the above process until no leaks are present. If no leaks are present, using caution to always maintain positive pressure, bleed the pressure to approximately 69 kPa (10 psi) and wait a minimum of ten minutes for entrapped air to flow to the high points. After the minimum ten minute period has expired, increase the pressure as needed and sequentially discharge grout at each high point outlet to eliminate entrapped air or water. Complete the process by locking a pressure of 207 kPa (30 psi) into the tendon by closing the grout inlet valve.

If the actual grouting pressure exceeds the maximum allowed, close the inlet and pump the grout at the next outlet that has just been, or is ready to be closed as long as a one-way flow is maintained. Do not pump grout into a succeeding outlet from which grout has not yet flowed. If this procedure is used, fit the outlet/inlet to be used for pumping with a positive shut-off and pressure gage.

When complete grouting of the tendon cannot be achieved by the steps stated herein, stop the grouting operation. Flushing immediately with water may be used to remove grout from the tendon. Do not exceed the allowable grouting pressures when flushing. If flushing is not successful or if electing not to flush, submit proposed repair procedures for approval.

When freezing weather conditions are possible during and following the placement of grout, keep ducts free of water to avoid damage due to freezing. At the time of grouting, have the surface temperature of the concrete in the member at 7 °C (45 °F) or higher and maintain at or above this temperature for 24 hours before and 48 hours after grouting. Do not allow the temperature of the grout to be less than 10 °C (50 °F) nor more than 32 °C (90 °F) during mixing, when measured at the mixer, or during pumping, when measured at the grout inlet.

During grouting and for a period of 4 hours after completion of grouting, eliminate vibrations from all contractor controlled sources such as moving vehicles, jackhammers, large compressors or generators, pile driving operations, soil compaction, etc., that are operating within 30 m (100 ft) of the ends of the span in which grouting is taking place.

After precast members have been grouted, do not move or otherwise disturb the members for a period of 24 hours. During cold weather conditions, when temperatures are below 10 °C (50 °F), do not move or disturb members for a period of 48 hours.

Do not remove or open inlets or outlets until grout has cured for a minimum of 24 hours. In the presence of the Engineer, investigate the ducts for voids between 24 hours and 7 days after grouting completion and within one hour of removal of an inlet or outlet. Remove the vent plugs from the top of each permanent grout cap to determine if the cap was completely filled with grout. Remove grout caps where removal of the vent plug indicates incomplete grouting. Reinstall vent plugs after inspection by the Engineer. Inspect inlet and outlet ports at the anchorages and at high points in the tendons for voids by drilling a minimum of 10%, randomly, as selected by the Engineer, and inspecting with a borescope. Use drilling equipment that will automatically shut off when steel is encountered during drilling so as not to damage strand. Depending on the geometry of the grout inlets/outlets, drilling may need to penetrate the inner surface of the trumpet or duct. Should any drilled hole inspection reveal a void with exposed strand, every anchorage shall be drilled. Completely fill voids found with secondary grouting in accordance with an approved grouting repair plan. Drilled holes not indicating voids shall be filled with epoxy using an injection tube extended to the bottom of the drilled hole and withdrawn as the epoxy is injected.

Provide a grouting report signed by the Contractor's ASBI or PTI trained technician within 72 hours of each grouting operation. Report the theoretical quantity of grout anticipated as compared to the actual quantity of grout used to fill the duct. Give notification immediately of shortages or overages. Information to be noted in the records shall include but not necessarily be limited to the following: identification of the tendon; date grouted; time grouting started and ended; number of days from tendon installation to grouting; type of grout; injection end and applied grouting pressure, ratio of actual to theoretical grout quantity; records of air and structure temperature during grouting; summary of tests performed and results; personnel carrying out the grouting work; summary of problems encountered and corrective action taken; summary of void investigations and repairs made.

Provide vacuum grouting equipment at the job site, when required for grouting repairs and when directed, consisting of the following:

1. Volumeter for the measurement of void volume.
2. Vacuum pump with a minimum capacity of 0.283 $m^3$ per minute (10 cfm) and equipped with flow-meter capable of measuring the amount of grout being injected.
3. Manual colloidal mixers and/or dissolvers (manual high speed shear mixers), for voids less than 20 L (5 gal) in volume.
4. Standard colloidal mixers, for voids 20 L (5 gal) and greater in volume.

Perform all vacuum grouting operations under the direct supervision of a crew foreman who has been trained and has experience in the use of vacuum grouting equipment and procedures.

(d) Grout for Pour-backs, Keyways, and Hole Repairs. Use nonshrink grout conforming to Subsection 503.02.03 for filling and repairing anchorage pour-backs, grout inlets and outlets, keyways and access holes.

Mechanically clean and abrasive blast clean the surface of concrete against which nonshrink grout is to be placed until clean aggregate is exposed. Abrasive blast clean the contact surfaces of existing concrete and any exposed reinforcing steel, as necessary, to remove all rust, paint, grease, asphalt or other foreign materials. Take necessary steps to not damage reinforcing steel coatings.

Remove ends of grout vents a minimum of 75 mm (3 in.) below the top of the top slab and a minimum of 50 mm (2 in.) from the bottom surface of all bottom slabs or vertical surfaces after grouting has been completed. Top slab grout vents extended to the edge of deck to exit within the barrier area may be removed flush with the surface of the deck. Use cored holes or formed blockouts with 25 mm (1 in.) minimum deep vertical edges at all sides. Do not use blockouts larger than 125 mm (5 in.) in largest horizontal dimension. Do not sawcut past corners on square blockouts to obtain the required vertical surfaces.

Following surface preparation, coat surfaces with Type II epoxy conforming to Subsection 728.03.02. Apply bonding agent to saturated surface dry concrete and in accordance with the manufacturer's recommendations.

Immediately prior to placing the nonshrink grout, re-clean all surfaces by air blasting, or by other approved means, as necessary to remove any debris which have accumulated during construction or after abrasive blast cleaning. Place nonshrink grout when surface temperature of the areas to be covered is between 7 and 32 °C (45 and 90 °F). Methods proposed to heat said surfaces are subject to approval by the Engineer. Place nonshrink grout when the contact surface is saturated surface-dry.

Cure nonshrink grout after initial set by continual wetting with water for a period of 48 hours. After 48 hours of wet curing, spray the nonshrink grout with two coats of curing compound as specified in Section 501.

Provide a flow cone and cube molds with restraining plates for onsite evaluation of nonshrink grout. Make three 50 mm by 50 mm (2 in. by 2 in.) cubes for each 0.5 $m^3$ (0.67 $yd^3$) of nonshrink grout used. Provide restraining caps for the cube molds in accordance with USACE CRD-C621. Store cubes at 21 °C (70 °F). Nonshrink grout cubes shall test equal to or greater than the specified minimum 28-day strength. Submit test reports for cubes for approval.

Do not use nonshrink grout that is caked, lumpy, or shows any signs of deterioration. Nonshrink grout will be rejected if the grout does not achieve the design fluidity or consistency when mixed according to the manufacturer's recommendations.

Nonshrink grout used in pourbacks exceeding 0.028 $m^3$ (1 $ft^3$) in volume may be extended by adding graded, dust-free, hard, 12.5 mm (1/2 in.) diameter rounded aggregate supplied by the grout manufacturer. Vibrate nonshrink grout extended with aggregate. Do not use calcareous aggregate made from limestone. Use mix proportions in conformance with manufacturer's written recommendations. Grout extended with aggregate shall meet the specified strength requirements.

Prior to deck grooving, coat the repaired access holes, block-outs and an area extending 150 mm (6 in.) outside the perimeter of the repair with an approved crack sealant specified in Section 646. Apply and remove excess material as per manufacturer's instructions.

**503.03.08 Curing Precast Members.** Cure precast members according to Subsection 501.03.08 or by accelerated curing. Inadequate curing facilities or lack of attention to proper curing of precast members will be cause for rejection of the precast member. When the curing compound method is used, abrasive blast clean portions of precast members upon which concrete will be cast later.

(a) Accelerated Curing. Perform low pressure steam or radiant heat curing under a waterproof enclosure that allows for free circulation of heat about the product and that is constructed to contain the live steam and heat with minimum moisture loss. Maintain a relative humidity within the enclosure of not less than 90% during the entire curing period.

Do not use accelerated curing methods that allow one portion of a member to cure differently than other portions of the member unless approved. Limit the temperature differential within the enclosure to no more than 11 °C (20 °F).

Steam shall be low-pressure and saturated. Do not apply live steam directly on the concrete, forms or test cylinders or so as to cause localized high temperatures.

Provide and use temperature probes to monitor the internal concrete temperature and the air temperature at the concrete surfaces within curing enclosures. Attach each temperature probe to a multi-channel continuous recording temperature device. Provide and use a minimum of 2 air temperature probes in each curing chamber, spaced approximately at or near the third points of the bed length. For curing chambers over 60 m (200 ft) in length, provide one additional air temperature probe for each 60 m (200 ft) increment. Provide a minimum of 2 concrete temperature probes embedded within the member located in areas that are expected to achieve the highest internal temperatures. Space temperature probes approximately at the third points the length of the member. Provide one

air temperature probe located outside of the curing enclosure in a shaded location. The system accuracy of the temperature probes and recording device shall be accurate to within 3 °C (5 °F) and recording devices shall continuously record the date, time, and temperatures of the enclosure and concrete during the entire heating and cooling cycles.

Provide temperature records for each member for approval prior to transporting the members. Missing or incomplete time-temperature records will be cause for rejection of the precast member.

After the last concrete is placed, maintain an internal concrete temperature between 10 °and 30 °C (50 and 86 °F) until the concrete has reached initial set as determined by ASTM C403. During the delay period before starting accelerated curing, keep exposed surfaces continuously wet using atomizing nozzles that form a fine mist or by the use of wet blankets.After initial set, apply heat at a rate such that the maximum internal concrete temperature does not increase more than 20 °C (36 °F) per hour.

Do not exceed a maximum internal concrete temperature of 82 °C (180 °F) at any point within the member during curing. Members subjected to temperatures beyond this maximum limit will be rejected and will not be considered for further evaluation for use. Maintain the maximum curing temperature uniform throughout the enclosure, with variation of not more than 11 °C (20 °F) from the maximum peak temperature until the concrete reaches the required release strength.

Allow the concrete element to cool gradually at a maximum cooling rate of 20 °C (36 °F) per hour and continue cooling until the concrete is not more than 20 °C (36 °F) above the ambient temperature outside the curing enclosure.

Transfer prestressing force into precast members immediately after accelerated curing is terminated.

Cure test cylinders under conditions that simulate those of the member. If the forms are heated by steam, locate test cylinders in the coolest zone throughout curing.

**503.03.09 Handling, Transporting, Storage, and Erection of Precast Members.** During handling, transport, storage, and erection, keep each precast girder vertical and upright to prevent twisting, racking, or other distortion that would result in cracking or damage to the precast member. Use equipment and erection methods that will not damage precast girders. Repair or replace damaged girders as determined by the Engineer. Repair all damaged girders by approved methods and materials. Lift precast girders only at their ends by approved lifting devices. Provide lateral bracing to prevent tipping or buckling.

Do not remove precast members from forms sooner than six hours after casting and not until the concrete strength is sufficient to avoid structural damage. For AASHTO Type V, Type VI, and Bulb-T Beams, do not remove the forms supporting the top flange concrete sooner than 12 hours after casting unless the release strength has been reached.

Transport precast girders at least 7 days after final concrete placement and upon reaching the required 28-day compressive strength.

Do not place any loads on precast units until the 28-day compressive design strength is reached.

Store precast members in the precast yard and at the jobsite on level, stable foundations that will keep them in a vertical position and prevent twisting or rotation. Support girders on only two points of support within a distance not greater than 3% of the beam length from their ends. When approved, cantilever beams may be supported at locations other than near the ends. Provide a clean and well drained storage area. Prevent excessive or differential settlement of members by storing them on stable ground and on dunnage of sufficient size, shape, and strength to prevent crushing. Immediately pick up members that have rotated or twisted and adjust supports to provide level and uniform support for the members.

Support concrete box beams and U-beams beneath end diaphragms during handling, storage, hauling, and erection.

When members are stacked, separate them with blocking arranged in vertical planes that will not crush under load. Stack members so that lifting devices are not damaged.

Rearrange improperly stored members and inspect them for damage. Members that are improperly stored and become cracked, warped, or otherwise damaged in storage may be rejected.

Where feasible, base the selection of storage sites, storage conditions and orientation upon consideration of minimizing the thermal and time-dependent creep and shrinkage effects on the camber and/or sweep of the members.

Measure and record the sweep and camber of beams monthly. Keep the measurement records on file for review at any time, and upon request, provide a copy of these measurements. If the sweep exceeds the tolerance specified, take immediate measures to bring the sweep of the product back to within tolerance. Give notification immediately when the sweep or camber exceeds the specified tolerances.

Provide tie-downs, anchors, temporary shoring, diaphragms, and other devices to keep members stable and in-place before they are permanently incorporated into the work.

When railroad or roadway traffic must be maintained beneath beams already placed, protect traffic against falling objects during the erection of diaphragms and other structural members, during the placing of cast-in-place concrete, and during the erection and dismantling of forms. Protect traffic with nets or flooring with openings not larger than 25 mm (1 in.) or as approved.

Provide 15 days written notice before starting erection.

Submit erection drawings according to Subsection 105.02. Do not consider the approval of erection drawings as relieving the responsibility for the safety and adequacy of methods or equipment or from carrying out the work in full accordance with the plans or specifications. Erection drawings shall include complete details of the erection plan and procedure to include but not limited to:

1. Procedure and sequence of operation.
2. Temporary falsework supports, bracing, and attachments to other structures.
3. Girder masses, lifting locations, lifting devices, and spreaders.
4. Cranes make and model, mass, geometry, lift capacity, and outrigger size and reactions.
5. Locations of cranes and delivery trucks.
6. Locations of crane outriggers relative to other structures including retaining walls and wingwalls.
7. In-place temporary tie-downs, anchors, diaphragms, bracing, and other devices.

Submit along with erection drawings, all notes, calculations, assumptions, and dimensions used in the development of the erection plan and procedure. Include material properties and specifications, structural analysis, and any other data used. Submit all changes to the erection drawings in writing for review and approval.

Correct beam discrepancies including, but not limited to, horizontal misalignment or variations in vertical camber, to achieve a satisfactory completed structure. Correction may require replacement of the member.

**503.03.10 Tolerances for Precast Members.** Fabricate precast prestressed concrete members to plan dimensions within the tolerances listed below (tolerances are not to be considered accumulative).

| Dimension | I-Beams and Bulb-Tee Beams | U-Beams | Box and Slab Beams |
|---|---|---|---|
| Length | ± 19 mm (3/4 in.) | ± 25 mm (1 in.) | ± 13 mm (1/2 in.) |
| Width | + 19 mm (3/4 in.), - 6 mm (1/4 in.) | ± 13 mm (1/2 in.) | ± 10 mm (3/8 in.) |
| Nominal depth | + 13 mm (1/2 in.), - 6 mm (1/4 in.) | ± 13 mm (1/2 in.) | ± 6 mm (1/4 in.) |
| Thickness: | | | |
| Top slab or flange | + 13 mm (1/2 in.), - 6 mm (1/4 in.) | ± 13 mm (1/2 in.) | ± 6 mm (1/4 in.) |
| Bottom slab or flange | + 13 mm (1/2 in.), - 6 mm (1/4 in.) | ± 13 mm (1/2 in.) | + 25 mm (1 in.), - 0 mm (0 in.) |
| Web or wall | + 19 mm (3/4 in.), - 6 mm (1/4 in.) | ± 13 mm (1/2 in.) | ± 6 mm (1/4 in.) |
| Horizontal alignment | — | — | ± 6 mm (1/4 in.) |
| per 3 m (10 ft) of length | ± 3 mm (1/8 in.) | ± 3 mm (1/8 in.) with ± 19 mm (3/4 in.) max. | — |
| Deviation of ends (horizontal skew) | ± 6 mm (1/4 in.) | — | — |
| per 0.3 m (1 ft) of width | — | ± 3 mm (1/8 in.) with ± 13 mm (1/2 in.) max. | ± 3 mm (1/8 in.) with ± 13 mm (1/2 in.) max. |
| Deviation of ends (vertical batter) | | | |
| per 0.3 m (1 ft) of width | ± 3 mm (1/8 in.) with ± 13 mm (1/2 in.) max. | ± 3 mm (1/8 in.) with ± 13 mm (1/2 in.) max. | ± 3 mm (1/8 in.) with ± 13 mm (1/2 in.) max. |
| Notched end areas, diaphragms: | | | |
| Depth | ± 6 mm (1/4 in.) | — | ± 6 mm (1/4 in.) |
| Length | + 50 mm (2 in.), - 25 mm (1 in.) | — | + 50 mm (2 in.), - 25 mm (1 in.) |
| Bearing surfaces: | | | |
| Perpendicular to vertical axis | ± 3 mm (1/8 in.) | — | — |
| Deviation from plane | ± 1.5 mm (1/16 in.) | ± 3 mm (1/8 in.) | ± 3 mm (1/8 in.) |
| Longitudinal spacing: | | | |
| Between centers of plates | ± 13 mm (1/2 in.) | ± 13 mm (1/2 in.) | ± 3 mm (1/2 in.) |
| Centers of plates to member ends | ± 13 mm (1/2 in.) | ± 13 mm (1/2 in.) | ± 13 mm (1/2 in.) |
| Insert or anchor hole location: | | | |
| From end of member | + 19 mm (3/4 in.), - 6 mm (1/4 in.) | ± 6 mm (1/4 in.) | ± 6 mm (1/4 in.) |
| Longitudinal spacing | ± 19 mm (3/4 in.) | ± 13 mm (1/2 in.) | ± 13 mm (1/2 in.) |
| Transverse location | ± 13 mm (1/2 in.) | ± 13 mm (1/2 in.) | ± 6 mm (1/4 in.) |
| Vertical location | ± 13 mm (1/2 in.) | ± 13 mm (1/2 in.) | ± 13 mm (1/2 in.) |
| Diaphragm or lateral tie location | ± 13 mm (1/2 in.) | — | ± 13 mm (1/2 in.) |
| Position of internal void form (longitudinal for box beams and U-beams) | — | ± 25 mm (1 in.) | ± 25 mm (1 in.) [1,2] |
| Projection of reinforcing outside of member | + 13 mm (1/2 in.), - 19 mm (3/4 in.) | + 13 mm (1/2 in.), - 19 mm (3/4 in.) | + 13 mm (1/2 in.), - 19 mm (3/4 in.) |
| Position of strand center of gravity: | | | |
| Vertical or Horizontal | ± 6 mm (1/4 in.) [3] | ± 6 mm (1/4 in.) | ± 6 mm (1/4 in.) |
| Debonded length of strands | ± 75 mm (3 in.) | ± 75 mm (3 in.) | ± 75 mm (3 in.) |
| Position of strand hold-down points | ± 150 mm (6 in.) | ± 150 mm (6 in.) | ± 150 mm (6 in.) |
| Position of handling devices: | | | |
| Parallel to length | ± 150 mm (6 in.) | ± 150 mm (6 in.) | ± 150 mm (6 in.) |
| Transverse to length | ± 25 mm (1 in.) | ± 25 mm (1 in.) | ± 25 mm (1 in.) |
| Local flatness of formed surfaces (excluding bearing surface) per 3 m (10 ft) | ± 6 mm (1/4 in.) | ± 6 mm (1/4 in.) | ± 6 mm (1/4 in.) |
| Position of post-tensioning ducts at ends of girders where spliced, vertical and horizontal | ± 13 mm (1/2 in.) | ± 13 mm (1/2 in.) | — |
| Camber differential: | | | |
| Between adjacent members | 25 mm (1 in.) max. | 13 mm (1/2 in.) max. | 13 mm (1/2 in.) max. |
| Between high and low members in same span | — | — | 25 mm (1 in.) max. |

[1] Voided box beams only.

[2] Length of box beam internal void form + 25 mm (1 in.), - 150 mm (6 in.).

[3] For draped strands, the tolerance for vertical position of the center of gravity of strands at the end of the beam may be increased to ± 13 mm (1/2 in.) provided the tested concrete compressive strength, before release of strand, is at least 5% greater than the release strength shown on the plans.

Horizontal misalignment (sweep) in beams, which may increase at a later time and exceed the tolerance specified, may be acceptable if the members can be hauled, erected, and aligned to within the allowable tolerance without being damaged. Store these members in a manner that will minimize the sweep.

Embedments shall be firmly held in proper position to avoid movement during concrete placement. Place embedments in accordance with the manufacturer's recommendations.

If stay-in-place metal deck forms are allowed, as shown on the plans, place weld clip inserts for permanent metal deck forming no more than 1.6 mm (1/16 in.) from the beam edge.

**503.03.11 Defects in Precast Members.** Evaluate and correct defects in precast members.

If defects affect the precast member's structural integrity, as determined by the Engineer, the precast concrete member will be rejected.

If the Engineer determines that a defect is a cosmetic or minor defect, appropriate repairs may be executed immediately according to Subsection 503.03.12. Perform and complete cosmetic and minor defect repairs to the satisfaction of the Engineer.

If the Engineer determines that a defect is a major defect, submit an engineering evaluation and repair proposal according to Subsection 503.03.12 (h). Make all repairs that require a repair proposal under the observation of and to the satisfaction of the Engineer.

(a) Surface Defects. Surface defects are defined below. Regardless of the types of defects, when the total surface area of all defects within a single product exceeds 2.0% of the product's length times its depth, the product will require evaluation and repair according to Subsection 503.03.12 (h).

1. Bug hole. A bug hole is a void caused by air that is entrapped against the form and that has an area up to 1935 $mm^2$ (3.0 $in^2$) and a depth up to 38 mm (1.5 in.). Treat any bug hole with a dimension exceeding either of these dimensions as a honeycomb. A bug hole with a depth less than 6 mm (0.25 in.) and less than 19 mm (0.75 in.) in diameter will not require repair. Consider all other bug holes cosmetic and repair them according to Subsection 503.03.12 (a).

2. Spall. A spall is a depression resulting when a fragment is detached from a larger mass by impact, action of weather, by pressure, or by expansion within the larger mass. A cosmetic spall is a circular or oval depression not greater than 25 mm (1.0 in.) in depth or greater than 1935 $mm^2$ (3.0 $in^2$) in area, and shall be repaired according to Subsection 503.03.12 (a).

With the exception of the spalls at the top flange of the beam-ends, a minor spall is defined as a spall not larger than 0.19 $m^2$ (2.0 $ft^2$) and no deeper than the concrete cover on the bar reinforcing steel. A spall located at the edge of the top flange, within 1/4 length from the beam-end, is considered a minor spall if the total longitudinal length of the defect does not exceed 3 m (10 ft) and if any of the lateral dimensions of the spall perpendicular to the longitudinal axis of the beam is not greater than 15% of the width of the top flange. Repair minor spalls according to Subsection 503.03.12 (c).

A major spall is a spall that any of its dimensions exceeds the dimensions that are described for minor spalls. Evaluate and repair major spalls according to Subsection 503.03.12 (h).

3. Chip. A chip is the local breaking of the corners or edges of the concrete with the resulting void containing angular surfaces. Cosmetic chips are chips where the sum of the two lateral dimensions perpendicular to the length does not exceed 50 mm (2.0 in.). Regardless of length, it is not necessary to repair cosmetic chips except for visually exposed reinforcing steel, prestressing strand, insert, or weldments surfaces, which may require repair according to Subsection 503.03.12 (d).

Minor chips are chips where the sum of the two lateral dimensions perpendicular to the length exceeds 50 mm (2.0 in.), but does not exceed 100 mm (4.0 in.), and with a length of no more than 0.3 m (1 ft). Repair minor chips according to Subsection 503.03.12 (d).

Major chips are chips larger than minor chips. Evaluate and repair major chips according to Subsection 503.03.12 (h).

4. Surface Porosity. Surface porosity is considered a minor defect and is the localized porosity of a formed surface due to medium scaling. Medium scaling is defined as the loss of surface mortar up to 9 mm (3/8 in.) in depth and exposure of concrete aggregate. Repair surface porosity according to Subsection 503.03.12 (b).

5. Honeycombing. Honeycombing is voids in the concrete, loss of fines or other material from between the aggregate particles, the inclusion of air pockets between aggregate particles, or larger volumes of lost material. Remove honeycombing in its entirety to sound concrete before establishing the classification of the defect.

Minor honeycombing is a void no deeper than the concrete cover on the bar reinforcing steel and no larger than 0.185 $m^2$ (2.0 $ft^2$) in area that results after the removal of unsound material. Repair minor honeycombing according to Subsection 503.03.12 (e).

Major honeycombing is a void deeper than concrete cover regardless of the surface area, or shallower but with a surface area greater than 0.185 $m^2$ (2.0 $ft^2$) that results after the removal of unsound material. Major honeycombing requires evaluation and repair according to Subsection 503.03.12 (h).

(b) Formed Surface Misshaping. Formed surface misshaping is the visual and measurable defect or excess of material from the specified tolerance on any surface of a product. Any defect exceeding the plan dimensions for size, length, squareness, designated skew, deviation from vertical, and the like by up to twice the specified plus (+) tolerance may be corrected by grinding to within the allowable tolerance according to Subsection 503.03.12 (f). Defects exceeding the specified minus (-) tolerance or twice the specified plus (+) tolerance requires evaluation and repair according to Subsection 503.03.12 (h).

(c) Bearing Areas. Consider the bearing area to extend from the end of the product to 75 mm (3 in.) beyond the edge of the bearing contact area for the full product width. Treat minor depressions in the bearing area, 3 mm (1/8 in.) maximum, with an approved low-viscosity epoxy, applied by the use of a squeegee. Grind bearing areas to final position with a carborundum disk if it is necessary to remove material.

(d) Cracks. A crack is the separation of a product or portion thereof which may appear before or after detensioning and may or may not cause separation throughout the product thickness or depth. Identify cracks by the classifications and locations described below and subject them to repair as specified. Regardless of the classifications and locations of cracks within any single product, if the total surface length of all cracks on any and all surfaces exceeds one-third of the product's length, the product requires evaluation and repair according to Subsection 503.03.12 (h). Establish crack sizes subsequent to release of all pretensioning forces.

Regardless of cause, cracks in precast members shall be identified and repaired according to their surface appearance in accordance with the classifications listed herein. Cracks will be identified by the Engineer as occurring in either critical or non-critical locations of the product.

Cosmetic cracks are classified as any cracks which are less than 0.15 mm (0.006 in.) wide and are in non-critical locations on the product. Minor cracks are classified as any cracks which are between 0.15 mm (0.006 in.) and 0.30 mm (0.012 in.) wide, inclusive, and are in non-critical locations on products. Repair cosmetic and minor cracks according to Subsection 503.03.12 (g).

Major cracks are any cracks of any width which are located in critical locations on products or cracks in non-critical locations of the product, which are greater than 0.30 mm (0.012 in.) wide. Major cracks require evaluation and repair according to Subsection 503.03.12 (h).

**503.03.12 Repair of Precast Members.** Repair cosmetic and minor defects in precast members and provide an engineering evaluation for the repair of major defects as indicated in Subsection 503.13.11 and herein. Submit proposed alternate repair methods for approval.

For each project, maintain a record of precast member defects and repair methods. Include in the record information about product description, unit production number, casting date, defect description including dimensions, repair method and materials, defect discovery date, and signature of producer's Quality Control Manager indicating concurrence with the information.

Do not ship products, which require repairs, from the casting yard to the project site until such repairs are complete and approved.

Before beginning the repair of member defects, remove laitance, loose material, form oil, curing compound and deleterious matter from repair area.

Nonshrink grout shall conform to Subsection 503.02.03. Mix, apply, and cure the grout in accordance with the manufacturer's recommendations.

Apply epoxy bonding agents according to the manufacturer's recommendations and as directed.

Cure repaired surfaces for 72 hours or as otherwise indicated in the written recommendations from the manufacturer of the repair products. Ensure the repaired surfaces have a surface texture, finish, and color that matches the appearance of the unaffected surrounding area of the product.

(a) Cosmetic Surface Filling. Fill repair areas with nonshrink grout. Coating of the prepared surface with epoxy bonding agent before grout placement is not required.

(b) Surface Restoration. Maintain the surface continuously wet for a minimum of three hours before application of repair material. Fill repair areas with a mortar mix consisting by volume of one part cement, 2.5 parts sand that will pass a 1.18 mm (No. 16) sieve, and sufficient water to produce a viscous slurry mix or repair areas to be restored with nonshrink grout and cure. Cure areas repaired with a mortar mix in accordance with Subsection 501.03.08. Coating of prepared surfaces with epoxy bonding agent before grout placement is not required.

(c) Cutting and Filling. Carefully cut all feathered edges of the area to be repaired back perpendicular to (or slightly undercut from) the surface to the depth of sound concrete or to a minimum depth of 13 mm (1/2 in.), whichever is deeper. Coat the prepared surface with an approved epoxy bonding agent. Fill the cutout area with nonshrink grout, firmly consolidate, and cure.

(d) Restoration of Surfaces and Edges. When reinforcing steel, prestressing strand, inserts or weldments are exposed, remove concrete from around the items to provide a 25 mm (1 in.) clearance all around or to sound concrete, whichever is more. Form surfaces and edges to the original dimensions and shape of the product. Coat the prepared surface with an approved epoxy bonding agent. Restore surfaces and edges with nonshrink grout, firmly consolidate, and cure.

(e) Removal and Restoration of Unsound Concrete. Carefully cut the area of unsound concrete to be repaired back perpendicular to (or slightly undercut from) the surface and to the depth of sound concrete or to a minimum depth of 25 mm (1 in.), whichever is deeper. When reinforcing steel, prestressing strand, inserts or weldments are exposed, remove the concrete from around the items to provide a 25 mm (1 in.) clearance all around or to sound concrete, whichever is more.

Coat the prepared surface with an approved epoxy bonding agent and fill with a nonshrink grout, firmly consolidate, and cure. Restore surfaces and edges to the original dimensions and shape of the product.

(f) Surface Grinding. Grind off misshaped formed surfaces with an abrasive stone. Apply two coats of an approved crack sealant specified in Section 646 to surfaces which are not subsequently encased in concrete, immediately after grinding has been accepted.

Do not apply crack sealant to surfaces to be subsequently encased in concrete.

(g) Crack Repair. Treat cosmetic cracks after member detensioning with spray-on waterproofing conforming to Section 646 and as approved. Treat horizontal cosmetically cracked surfaces that will be exposed in the completed structure with crack sealant conforming to Section 646.

Repair minor cracks after member detensioning by epoxy injection with epoxy conforming to Subsection 728.03.01.

Prior to commencing epoxy injection repair, submit specifications on the epoxy materials and injection equipment, Material Safety Data Sheets, and a written procedure for the injection process.

Clean the areas surrounding the crack of deteriorated concrete. Remove contaminants that may be detrimental to adhesion. The crack may be ruffed or veed in to accommodate insertion of injection ports.

Perform drilling of the crack for injection ports with a vacuum attached swivel drill chuck. The crack may be slotted to facilitate installation of injection tees.

Seal the surface of the crack and the area surrounding the entry ports with an approved epoxy. Use approved entry port devices spaced at intervals to insure full penetration of the epoxy. Use a surface seal epoxy of adequate strength to hold injection ports firmly in place and to resist injection pressures to prevent leakage during injection.

Accomplish injection of the epoxy by a machine capable of metering and mixing the component proportions with a tolerance of 2.0%. Operate the injection machine at a nozzle pressure of approximately 172 kPa (25 psi).

Begin injection of epoxy at the lower entry port and continue until appearance of epoxy at the adjacent port. Perform epoxy injection in the next adjacent port where epoxy has appeared. Continue this operation until the cracks are completely filled.

Upon completion of the injection of epoxy and after initial cure, remove the entry ports and patch the area.

(h) Engineering Evaluation and Repair Proposal. For repair of major defects, submit an engineering evaluation and repair proposal for approval. Allow 14 days for proposal review and final disposition. Do not commence repairs to major defects before receiving written approval of the proposal. Include the following information in the proposal:

1. A cover letter indicating that the proposal has been prepared under the direction of an engineer who is registered as a Civil or Structural Engineer in the State of Nevada.
2. A description of the products addressed as part of the proposal.
3. Information documenting complete details of the product defects.
4. Description of the proposed repair procedures including repair materials, product preparation, and curing of repair materials.
5. A structural assessment of the repaired product's ability to perform its intended function.
6. An assessment of durability of the repaired product relative to similar, defect-free products.
7. Any other supportive information, pictures, and sketches.

When requested, provide a signed and sealed statement from the registered engineer who prepared the proposal that they have physically inspected the repairs and attest the repairs have been performed in full conformance with the approved proposal.

**503.03.13 Surface Finish of Precast Members.** Apply an ordinary surface finish to all precast concrete member surfaces as described in Subsection 502.03.18, unless otherwise noted on the plans.

Finish the top interface between precast concrete members and cast-in-place concrete decks by screeding the concrete to provide a dense surface without a smooth sheen or laitance. Just prior to the concrete reaching its initial set, texture the interface surface. Use a steel brooming tool to etch the surface transversely to the member leaving grooves 6 mm (1/4 in.) to 13 mm (1/2 in.) wide, between 6 mm (1/4 in.) and 13 mm (1/2 in.) deep, and spaced 6 mm (1/4 in.) to 13 mm (1/2 in.) apart.

## METHOD OF MEASUREMENT

**503.04.01 Measurement.** Precast concrete members (reinforced or prestressed) will be measured by the each. The length of the members shown in the estimate of quantities and/or in the proposal are nominal. For exact length see the drawings of the members shown on the plans.

If concrete in precast concrete members fails to meet the specified 28 day compressive strength, liquidated damages will be assessed or the concrete will be rejected, all according to Sections 501 and 502. Liquidated damages will be based on the value of the concrete in a given member being equal to 50% of the contract unit price bid per unit for the members.

Prestressing cast-in-place concrete will be measured by the lump sum.

The concrete for post-tensioned cast-in-place concrete structures will be measured under Section 502. The reinforcing steel for post-tensioned cast-in-place concrete structures will be measured under Section 505. Additional concrete or reinforcing steel required by the particular system used will not be measured or paid for directly.

## BASIS OF PAYMENT

**503.05.01 Payment.** The accepted quantities, measured as provided above, will be paid for at the contract price per unit of measurement for the pay items listed below that are shown in the proposal. Payment will be full compensation for the work prescribed in this Section.

Payment will be made under:

| Pay Item | Pay Unit |
|---|---|
| (length) Precast Concrete Members | Each |
| Prestressing Cast-In-Place Concrete | Lump Sum |

# SECTION 504

## LIGHTWEIGHT CONCRETE FOR STRUCTURES

### DESCRIPTION

**504.01.01 General.** This work consists of furnishing and placing lightweight Portland cement concrete in bridges, culverts, and other types of concrete structures.

### MATERIALS

**504.02.01 General.** Material shall conform to the following Sections and Subsection:

| | |
|---|---|
| Portland Cement Concrete | Section 501 |
| Admixtures | Subsection 501.02.04 |
| Concrete Structures | Section 502 |
| Aggregates for Portland Cement Products | Section 706 |

**504.02.02 Concrete Making Properties.** Lightweight concrete shall be subject to the following requirements and test methods:

| Test | Test Method | Requirements |
|---|---|---|
| Making Test Specimens (laboratory) | ASTM C192 | — |
| Making Test Specimens (field) | Nev. T428 | — |
| Compressive Strength | ASTM C39 * | Table I |
| Unit Weight & Cement Factor (wet) | Nev. T435 | Table I |
| Tests for Popouts | ASTM C330 | No Surface Popouts |
| Air Content | Nev. T431 | Table I |
| Slump | Nev. T438 | Table I |
| Air Dried Weight | ASTM C567 | Table I |
| Coring Concrete | ASTM C42 | Subsection 504.04.01 |

* The compressive strength requirements of Portland cement concrete will be based on the strength test, which is defined as the average of the breaking strength of 3 standard cylinders at 28 days.

The compressive strength test will be required for each 38 $m^3$ (50 $yd^3$), or portion thereof, placed each day. For large continuous pours, one test near the beginning of the pour and one test near the end of the pour may be substituted for the 38 $m^3$ (50 $yd^3$) requirement. Other cylinders may be made and broken for informational purposes.

### CONSTRUCTION

**504.03.01 General.** The construction of conventionally reinforced lightweight concrete structures shall conform to Sections 501 and 502, with the exceptions contained in this Section.

Give not less than 32 days notification in advance of use of the proposed sources of materials and make arrangements for the Engineer to obtain samples as required for testing purposes. Samples will not exceed 225 kg (500 lb) for each separate grading.

Furnish a written statement giving the amount of cement in $kg/m^3$ ($lb/yd^3$), the proportions of cement and each size of aggregate in a saturated surface dry condition, the slump, and the percentage of air in the concrete proposed for use in the work. If proposing to use an admixture other than an air-entraining agent, state its complete brand name and the quantity proposed to be used per $m^3$ ($yd^3$) of concrete. The Engineer, after making such tests as deemed advisable, will either accept the proposed materials and proportions or suggest modifications needed for acceptance.

After acceptance of batch proportions and materials, do not alter them during the course of the work except as found necessary to maintain yield, amount of cement, and unit mass within specification requirements. Do not revise batch proportions resulting in concrete that contains an amount of total water per cubic meter (cubic yard) greater than 105% of that contained in concrete of the accepted proportions.

**504.03.02 Storage of Aggregates.** Stockpile lightweight aggregate on the job or at a central batching plant for a minimum time of 24 hours before its use.

Stockpile fine and coarse aggregates separately.

**504.03.03 Classification and Proportions.** Proportion lightweight concrete by mass, such that the requirements in Table I will be satisfied. Give advance notice in writing when any changes are to be made in the batch proportions.

Do not vary batches of lightweight concrete more than ± 50 kg/m$^3$ (± 3 lb/ft$^3$) in unit mass from the design mix. The amount of cement of any individual batch placed in the work shall not be more than 8 kg/m$^3$ (14 lb/yd$^3$) less nor more than 14 kg/m$^3$ (23 lb/yd$^3$) greater than the amount designated on the design mix. Batch aggregates and report to the Engineer by mass. The masses used may be varied as necessary to comply with the above tolerances in amount of cement and unit mass.

**TABLE I**

| Class of Concrete | Cement Range kg/m$^3$ (lb/yd$^3$) | Maximum Water Cement Ratio kg/kg (lb/lb) | Minimum Compressive Strength MPa (psi) | Slump Range mm (in.) | Entrained Air Range % | Maximum Air Dried Mass kg/m$^3$ (lb/ft$^3$) |
|---|---|---|---|---|---|---|
| LA | 330-420 (564-705) | 0.53 (0.53) | 21 (3,000) | 25-100 (1-4) | — | 1,842 (115) |
| LAA | 330-450 (564-752) | 0.49 (0.49) | 21 (3,000) | 25-100 (1-4) | 4-7 | 1,842 (115) |
| LA or LAA, Modified | 360-450 (611-752) | 0.53 (0.53) | Specified on Plans | 25-100 (1-4) | 4-7 | 1,842 (115) |

The maximum water/cement ratio is based on aggregate in a saturated surface dry condition.

Natural fine aggregate may be used provided it does not result in concrete having a mass in excess of maximum.

**504.03.04 Mixing.** Produce workable concrete of uniform consistency. Use stockpiled aggregates in a saturated surface dry condition just before batching.

Charge the batch so that 75% of the total mixing water and admixtures are introduced in the mixer in advance of the aggregates. Introduce the aggregates and mix for a minimum of 45 seconds. The amount of absorption by the aggregate will be the determining factor in mixing time. Add the cement and final water and complete mixing. For stationary mixers, mix not less than 3 minutes. For truck mixers, mix not less than 100 revolutions of the drum.

Operate the drum on truck mixers at high speed while charging it with aggregate. Introduce cement into the mixing drum while it is rotating at slow speed. Immediately before discharge of the concrete, rotate the drum at high speed for at least 60 seconds.

## METHOD OF MEASUREMENT

**504.04.01 Measurement.** Lightweight concrete will be measured according to Subsection 502.04.01.

Reinforcing steel will be measured under Section 505.

## BASIS OF PAYMENT

**504.05.01 Payment.** The accepted quantities, measured as provided above, will be paid for at the contract price per unit of measurement for the pay items listed below that are shown in the proposal. Payment will be full compensation for the work prescribed in this Section.

Payment will be made under:

| Pay Item | Pay Unit |
|---|---|
| (class) Lightweight Concrete (Minor) | Cubic Meter (Cubic Yard) |
| (class) Lightweight Concrete (Major) | Cubic Meter (Cubic Yard) |

# SECTION 505

## REINFORCING STEEL

DESCRIPTION

**505.01.01 General.** This work consists of furnishing and placing reinforcing steel and welded wire reinforcement.

MATERIALS

**505.02.01 General.** Material shall conform to the following Subsections:

| | |
|---|---|
| Bar Steel Reinforcement | Subsection 713.03.01 |
| Welded Wire Reinforcement | Subsection 713.03.02 |

Use Grade 420 (60) bar steel reinforcement unless otherwise specified on the plans.

Spiral reinforcement may be either bar steel reinforcement or steel wire, of the equivalent size of the bar steel.

Use epoxy coatings listed in the QPL.

Tie wire shall be commercial quality 1.5 mm diameter (16 gage) minimum, black annealed soft-iron wire, unless otherwise approved. Tie wires used on epoxy coated reinforcing steel shall be coated with plastic or an equal type coating as approved.

**505.02.02 Samples.** Furnish one extra bar of each diameter for each 90 metric tons (100 tons) or fraction thereof. Select this bar from the longest bar of each size so that the bar, or a portion of it, can be used to replace any bar of that diameter which is selected to be used as a field sample. Supply field sample of sufficient length to provide for two 750 mm (30 in.) samples of each diameter. Indicate the extra bars on the fabricator's details.

**505.02.03 Specifications for Coating Reinforcing Steel.** Coating of bar steel reinforcement shall conform to AASHTO M284 (ASTM A775). Fabrication and handling of coated reinforcing steel shall conform to AASHTO M317 (ASTM D3963) except as provided herein. Patching or repair material shall conform to AASHTO M284 (ASTM A775) and shall be obtained from the coating manufacturer utilized to initially coat the reinforcement.

Coating of welded wire reinforcement shall conform to ASTM A884, Class A. When approved in writing, zinc coating conforming to ASTM A993 may be substituted for epoxy coating.

The coating fabricator for epoxy coated reinforcing steel shall be certified by the Concrete Reinforcing Steel Institute's Certification Program for Fusion Bonded Epoxy Coating Applicator Plants. Submit a copy of the Epoxy Coating Certification along with notification of the starting date of coating application.

Give notification of the date and location of the coating operation, in writing, at least 10 days before the planned date for beginning the coating operation. Allow the Engineer free access to the plant of the coating applicator for inspection. If the representative so elects, perform preparation of the bars, coating and curing of the bars in the representative's presence.

**505.02.04 Welded Hoop Reinforcing.** Fabricate welded hoop reinforcing consisting of bar steel reinforcing formed into a circular shape with ends connected by complete joint penetration butt welding or resistance butt welding according to Subsection 505.03.05 and the requirements herein.

(a) General. Designate in writing a welded hoop reinforcing Quality Control Manager (QCM). The QCM shall be responsible directly to the Contractor for the quality of all welded hoop reinforcing including the inspection of materials and workmanship performed by the Contractor and all subcontractors and submitting, receiving, and approving all correspondence, required submittals, and reports regarding welded hoop reinforcing to and from the Engineer.

The QCM shall not be employed or compensated by any subcontractor, or by other persons or entities hired by subcontractors, who will provide other services or materials for the project. The QCM may be an employee of the Contractor. The QCM shall be qualified as an AWS Certified Welding Inspector or approved equivalent and shall have a minimum of 3 years experience in the inspection/oversight of reinforcing steel welding. Provide verification of QCM qualifications at least 10 days before the planned date for beginning the welding operation.

Identify in writing an independent qualified testing laboratory that will be used to perform testing of all welded hoop reinforcing sample splices and control bars. The independent testing laboratory shall not be employed or compensated by any subcontractor, or by other persons or entities hired by subcontractors who will provide other services or materials for the project.

The testing laboratory shall have proper facilities, including a tensile testing machine capable of breaking the largest size of reinforcing bar to be tested. Testing personnel shall have received formal training for performing the testing requirements of ASTM A370. The laboratory shall have a record of annual calibration of testing equipment performed by an independent third party that has standards in conformance with the National Institute of Standards and Technology and a formal reporting procedure, including published test forms.

(b) Sampling and Testing. Prepare all pre-production, production, and job control sample welded splices to be a minimum length of 1.5 m (5 ft) for reinforcing bars No. 25 (# 8) or smaller and 2.0 m (6.5 ft) for reinforcing bars No. 29 (#9) or larger, with the welded splice located at the midpoint. Suitably identify samples prior to shipment with weatherproof markings that do not interfere with the Engineer's tamper-proof markings or seals. Sample splices that show signs of tampering will be rejected.

Remove a minimum of one control bar from the same bar as, and adjacent to the pre-production, production, and job control sample welded splices. Control bars shall be a minimum length of 1 m (3 ft) for reinforcing bars No. 25 (#8) or smaller and 1.5 m (5 ft) for reinforcing bars No. 29 (#9) or larger. Suitably identify samples prior to shipment with weatherproof markings that do not interfere with the Engineer's tamper-proof markings or seals. The portion of adjacent bar remaining in the work shall also be identified with weatherproof markings that correspond to its adjacent control bar.

Shorter length sample splice and control bars may be furnished if approved in writing.

Identify, and mark as a set, each sample splice and its associated control bar. Identify each set as representing a pre-production, production, or job control sample splice.

Replace in kind welded hoop reinforcing with portions removed to obtain a sample splice and control bar.

Test all pre-production, production, and job control sample splices according to ASTM A370.

Pre-production, production, and job control sample splices shall rupture in the reinforcing bar either outside of the affected zone or within the affected zone, provided that the sample has achieved at least 95% of the ultimate tensile strength of the control bar associated with the sample. Necking of the bar shall be visibly evident at rupture regardless of whether the bar breaks inside or outside the affected zone.

The affected zone is the portion of the reinforcing bar where any properties of the bar, including the physical, metallurgical, or material characteristics, have been altered by fabrication or installation of the splice.

Determine, regardless of where each sample splice ruptures, the ultimate tensile strength of each control bar. If 2 control bars are tested for one sample splice, the bar with lower ultimate tensile strength shall be considered the control bar.

(c) Pre-Production Tests. Perform pre-production testing of sample splices and control bars prior to commencing production of welded hoop reinforcing.

Fabricate 8 pre-production sample splices for each hoop type including complete joint penetration butt welded splices or resistance butt welded splices that shall be used in the work. Provide 8 pre-production control bars sampled from the bar reinforcing used to fabricate the sample splices.

Fabricate the sample splices using the same materials, position, operators, location, and equipment, and procedures that will be used to fabricate the welded hoop reinforcing. Resistance butt welded sample splices shall have the weld flash removed.

Welder qualification tests may be performed simultaneously with the preparation of pre-production samples.

If different diameters of hoops for the same size bars are shown on the plans, pre-production samples, as described above, will only be required for the smallest hoop diameter. Fabricate sample splices using the same radius as shown on the plans for these hoops.

Unless otherwise directed, provide 4 sets of pre-production sample splices and control bar sets to the Engineer and have the remaining 4 sets tested using the Contractor's independent testing laboratory.

Securely bundle together and identify by location and contract number with weatherproof markings each group of 4 sets from a pre-production test prior to shipment. Bundles containing fewer than 4 sets will not be tested by the Department, nor shall they be tested by the independent laboratory.

Test sets of sample splices and control bars according to testing requirements specified above in (b) Sampling and Testing.

For each bundle of 4 sets, prepare a Pre-production Test Report. The report shall be signed by an Engineer who represents the laboratory and is registered as a Civil Engineer in the State of Nevada. Include in the report the following information for each set: contract number, bridge number, bar size, type of splice, physical condition of test sample splice and control bar, notable defects, limits of affected zone, location of visible necking area, ultimate strength of each splice, ultimate strength and 95% of this ultimate strength for each control bar, and a comparison between 95% of the ultimate strength of each control bar and the ultimate strength of its associated splice. Submit the report to the QCM for review and approval, and then to the Engineer.

Test results for each bundle of 4 sets will be reported in writing to the Contractor within 14 days after receipt of the bundle by the Department. In the event that more than 1 bundle is received on the same day, allow an additional 2 working days for reporting of test results for each additional bundle received. A test report will be made for each bundle received.

(d) Production Test Requirements. Perform production tests for all welded hoop reinforcing used in the work. A production test consists of 4 sets of sample splices and control bars removed from each lot of completed splices.

A lot of welded hoops is defined as 150, or fraction thereof, of fabricated hoops for each specified bar size. If different diameters of hoop reinforcement are shown on the plans, use separate lots for each different hoop diameter.

After all welded hoops in a lot have been completed, the QCM shall notify the Engineer in writing that all hoops in the lot conform to these specifications and are ready for testing. Upon notification, the Engineer will randomly select the 4 sample splices to be removed from the lot and place tamper-proof markings or seals on them. The Contractor or QCM shall select the adjacent control bar for each sample splice bar, and the Engineer will place tamper-proof markings or seals on them.

Remove sample splices and control bars and securely bundle together for shipment to the independent laboratory. Test sample splices and control bars according to testing requirements specified above in (b) Sampling and Testing.

Do not test bundles containing fewer than 4 sets of sample splices and control bars.

Provide 7 days notice before the samples are tested at the laboratory. Conduct testing in the presence of the Engineer or authorized representative.

A sample splice or control bar from any set will be rejected if tamper-proof markings or seals are disturbed prior to testing.

The independent testing laboratory shall prepare and submit a Production Test Report for all testing performed on each lot to the QCM for review and approval. The report shall be signed by an Engineer who represents the laboratory and is registered as a Civil Engineer in the State of Nevada. Include in the report the following information for each set: contract number, bridge number, lot number and location, bar size, type of splice, physical condition of test sample splice and control bar, notable defects, limits of affected zone, location of visible necking area, ultimate strength of each splice, ultimate strength and 95% of this ultimate strength for each control bar, and a comparison between 95% of the ultimate strength of each control bar and the ultimate strength of its associated splice.

The QCM shall review, approve, and forward each Production Test Report to the Engineer for review before any splices represented by the report are encased in concrete. The Engineer will have 7 days to review each Production Test Report. Should the Contractor elect to encase any splices prior to receiving notification from the Engineer, it is expressly understood that the Contractor shall not be relieved of the requirements specified in Subsection 105.12.

If 3 or more sample splices from any production test meet the test requirements, all hoops in the lot represented by this production test will be considered acceptable.

Should only 2 sample splices from any production test meet the test requirements, one additional production test shall be performed on the same lot of hoops. Should any of the 4 sample splices from this additional test fail to conform to these provisions, all welded hoops in the lot represented by these production tests will be rejected.

If only 1 sample splice from any production test meets the test requirements, all hoops in the lot represented by this production test will be rejected.

Whenever any lot of welded hoop reinforcing is rejected, additional welded hoops shall not be fabricated or used in the work until the QCM performs a complete review of the Contractor's quality control process for these splices and written report is submitted describing the cause of failure for the splices in this lot and provisions for correcting these failures in future lots. Do not resume fabrication until the Engineer has provided written notification that the report is acceptable.

(e) Job Control Tests. For the first production test performed, and for at least 1, randomly selected by the Engineer, of every 5 additional production tests, or portion thereof, performed thereafter, concurrently prepare a job control lot consisting of 4 sets of sample splices and control bars. Prepare these job control sets in the same manner as specified for pre-production sample splices and control bars.

For each job control lot, ship 2 sets of sample splices and control bars for testing at the independent laboratory. Provide the 2 remaining sets to the Engineer for comparison testing. Securely bundle together and identify the sets by location and contract number with weatherproof markings prior to shipment.

All job control sets of sample splices and control bars shall be tested according to the testing requirements specified above in (b) Sampling and Testing.

The independent testing laboratory shall prepare and submit a Job Control Test Report for all testing performed on each lot to the QCM for review and approval. The report shall be signed by an Engineer who represents the laboratory and is registered as a Civil Engineer in the State of Nevada. Include in the report the following information for each set: contract number, bridge number, lot number and location, bar size, type of splice, physical condition of test sample splice and control bar, any notable defects, limits of affected zone, location of visible necking area, ultimate strength of each splice, ultimate strength and 95% of this ultimate strength for each control bar, and a comparison between 95% of the ultimate strength of each control bar and the ultimate strength of its associated splice.

Test results for each bundle of 2 sets will be reported in writing to the Contractor within 14 days after receipt of the bundle by the Engineer. In the event that more than 1 bundle is received on the same day, allow 3 additional working days for providing test results for each additional bundle received. A test report will be made for each bundle received. Should the Contractor elect to encase any splices prior to receiving notification from the Engineer, it is expressly understood that the Contractor shall not be relieved of the requirements specified in Subsection 105.12.

**505.02.05 Headed Bar Reinforcement.** Headed bar reinforcement, consisting of friction welded or integrally forged heads onto 1 or both ends of bar reinforcement, shall conform to ASTM A970, including appendixes, and the details shown on the plans.

Prior to performing any manufacturing, submit the manufacturer's Quality Control (QC) manual for the fabrication of headed bar reinforcement. The QC manual shall include pre-production procedures for the qualification of materials and equipment, methods and frequencies for performing QC procedures during production, calibration procedures and calibration frequency for all equipment, a system for the identification and tracking of friction welds with provisions for permanently identifying each weld and the parameters used to perform it, welding procedure specification (WPS) for friction welded headed bar reinforcement, and a system for marking headed bar reinforcement.

Be responsible for Quality Control. Perform inspection and testing prior to, during, and after welding or forging, and as necessary to ensure that materials and workmanship conform to the specifications.

The manufacturer shall keep a daily production log for the manufacture of headed bar reinforcement for each day of production lot. The log shall clearly indicate the production lot numbers, the heats of bar material and head material used in the manufacture of each production lot, the number of bars in each production lot, welding or forging records, including tracking and production parameters for welds or forgings, and results of all tests performed.

A production lot of friction welded or integrally forged headed bar reinforcement is defined as 150 reinforcing bars, or fraction thereof, of the same bar size, with heads of the same size and type, produced from bar material of a single heat number and head material of a single heat number. Start a new production lot if the heat number of either the bar material or the head material changes before the maximum production lot size of 150 is reached.

Submit the daily production log within 7 days following the manufacture of headed bar reinforcement.

Furnish manufacturer certificates of compliance accompanied by a copy of the mill test report.

Forging of heads or integrally forged headed bar reinforcement shall conform to ASTM A788.

Welding, welder qualifications, and inspection of welding shall conform to the requirements for friction welding in ANSI/AWS C6.1.

Perform welding or forging at an established and permanent fabrication facility.

Fit equipment used to perform friction welding with an effective in-process monitoring system to record essential production parameters that describe the process of welding the head onto the bar reinforcement. Record the friction welding force, forge force, rotational speed, friction upset distance and time, forge upset distance and time, and other elements of the production process. Record the data from this in-process monitoring and preserve the data for a minimum of 1 year after manufacture of the friction welded headed bars and provide the data upon request.

Alternative head dimensions different from those specified on the plans may be allowed upon approval. Design the alternative head dimensions using the concrete compressive strength shown on the plans and in conformance with these specifications. Alternative head dimensions will not be considered for approval unless it can be demonstrated that the alternative heads have been successfully produced and have had at least 2 years of satisfactory service in conditions similar to this application. Furnish documentation satisfactory to the Engineer that the alternative head dimensions are suitable for the intended application.

Alternative head dimension documentation shall include calculations and test reports showing the alternative head is capable of resisting the nominal tensile strength of the reinforcing bar when the bar reinforcement with the welded or forged head is embedded in concrete, shear or bending forces do not cause premature failure of the alternative head or crushing failure of the concrete under the alternative head.

(a) Acceptance Tests. Perform acceptance tests at the manufacturer's plant or at a qualified laboratory with traceability to the National Institute of Standards and Technology (NIST), and in the presence of the Engineer, unless otherwise directed in writing.

Test samples will be randomly selected from each production lot of friction welded or integrally forged headed bar reinforcement, which is ready for shipment to the job site. Give notification in writing at least 7 days prior to conducting tests.

Test a minimum of 3 samples of friction welded or integrally forged headed bar reinforcement from each production lot. Conduct 1 tensile test on each sample.

Tensile tests shall conform to the requirements of "Tensile Test Criteria" specified in Section 7 of ASTM A970, except that at rupture, there shall be visible signs of necking in the reinforcing bar at a minimum distance of 1 bar diameter away from the head to bar connection. If 1 of the test specimens fails to meet the specified requirements, perform 1 retest on 1 additional sample, selected by the Engineer, from the same production lot. If the additional test specimen, or if more than 1 of the original test specimens, fail to meet these requirements, all friction welded or integrally forged headed bar reinforcement represented by the tests will be rejected.

Tag all headed bar reinforcement of each bar size from each production lot to be shipped in a manner that each production lot can be accurately identified at the job site. All unidentified headed bar reinforcement received at the job site will be rejected.

CONSTRUCTION

**505.03.01 Bending Diagrams.** Before placing plan reinforcing steel, furnish 2 sets of reinforcing steel bending and cutting diagrams. Furnishing the bending and cutting diagrams shall not be construed to mean that the bending and cutting diagrams will be reviewed for accuracy. Be solely responsible for the accuracy of the diagrams.

Submit 5 sets of proposed changes to plan reinforcing steel, separate from the bending and cutting diagrams. Allow 30 days for review and approval of such proposed changes. Additional contract time will not be given for proposed changes requiring corrections and re-submittal. Do not place reinforcing steel affected by proposed changes until given approval.

**505.03.02 Protection of Materials.** Protect reinforcing steel at all times from damage. When placed in the work, keep the reinforcing steel free from detrimental substances such as loose rust, dirt, detrimental scale, paint, oil, or other foreign substance. Clean detrimental substances from reinforcing steel by an approved method.

Thoroughly inspect the coated steel after delivery to the job-site, and again after installation in the forms, to ensure that it is not damaged; and when there is damage, that it has been properly patched. Promptly patch sheared ends and other cuts or exposed areas before detrimental oxidation occurs.

Repair all damage, visible to the unaided eye, caused during shipment, storage, or placement of coated bars at the job-site with patching material conforming to Subsection 505.02.03.

The total damaged surface area (prior to repair with patching material), shall not exceed 2%. The total bar surface area covered by patching material either at the shop or at the job-site, shall not exceed 5%. Bars exceeding these limits will be rejected and shall be replaced.

Properly store coated bars. If stored outside for more than 2 months, store off the ground, and cover for protection against both moisture and ultraviolet light, in such a manner that condensation does not form on the bars.

When handling coated bars, use systems with padded contact areas. Pad bundling bands. Lift bundles with a strong-back, multiple supports, or a platform bridge so as to prevent bar to bar abrasion from sags in the bar bundle. Do not drop or drag bars or bundles.

**505.03.03 Bending.** Cut and bend reinforcing steel to the shapes shown on the plans. Fabrication tolerances for straight and bent bars shall be according to ACI 315.

Cold bend all bars, unless otherwise permitted. Do not bend bars embedded in concrete, except as shown on the plans or as specifically permitted. When the dimensions of hooks or the diameter of bends are not shown on the plans, provide them according to ACI 318. Ship reinforcing steel in standard bundles, tagged and marked according to the Manual of Standard Practice of Concrete Reinforcing Steel Institute.

Submit a bending procedure for approval before field bending any bars. Splice bars which are damaged or broken according to Subsection 505.03.05. Submit the method of splicing for approval.

Perform field bending to the following minimum diameters unless smaller diameters are approved:

| Metric Bar Size No. | English Bar Size # | Minimum Bending Diameter mm (in.) |
|---|---|---|
| 13 | 4 | 75 (3) |
| 16 | 5 | 100 (4) |
| 19 | 6 | 125 (5) |
| 22 | 7 | 150 (6) |
| 25 | 8 | 200 (8) |
| Above 25 | Above 8 | Bending and straightening not recommended. |

Perform bending with a smooth continuous application of force. If a hickey bar is used in straightening a bar, perform by progressively moving the hickey bar around the bend.

**505.03.04 Placing and Fastening.** Accurately place all bar reinforcement in the positions shown on the plans and firmly hold during the placing and setting of concrete. When the spacing of bars exceeds 300 mm (12 in.) in either direction, tie all intersections. When the spacing of bars is 300 mm (12 in.) or less in both directions, tie alternate intersections.

Maintain distance from the vertical and horizontal forms by means of stays, blocks, ties, hangers, or other approved supports. Hold reinforcing bars from contact with the forms or between layers of bars by use of precast mortar blocks of approved shape, dimensions and compressive strength of not less than 21 MPa (3,000 psi). Fabricate metal chairs which are in contact with the exterior surface of the concrete of either galvanized steel, or with steel tips plastic coated to at least 19 mm (3/4 in.) into the concrete, or of stainless steel conforming to ASTM A493, Type 430. Do not use pebbles, pieces of broken stone, brick, metal pipe, or wooden blocks. Do not place concrete until reinforcement is inspected and approved. Concrete placed in violation of this provision may be rejected and its removal required.

If welded wire reinforcement is shipped in rolls, straighten into flat sheets before placing.

For epoxy coated reinforcing steel, use compatible types of bar supports to minimize damage to the coating on the bars during field placing. Make bar supports of dielectric material or coat with dielectric material. If precast concrete blocks with embedded tie wires or precast concrete doweled blocks are used, epoxy coat or plastic coat the wires or dowels. Epoxy coat reinforcing bars that are used as support bars. In walls reinforced with epoxy coated bars, epoxy coat spreader bars. Make proprietary combination bar clips and spreaders that are used in walls of corrosion resistant material or coat with dielectric material. Coat wire bar supports with dielectric material, such as epoxy or plastic, for a distance of at least 50 mm (2 in.) from point of contact with the epoxy coated reinforcing bars.

The following requirements shall apply to epoxy coated and plastic coated wire bar supports:

1. Keep the wire surface free of contaminants that affect the adhesion of the epoxy coating or plastic coating to the wire.

2. Apply the epoxy coating by the electrostatic spray method, fluidized bed, or by flocking.

3. Apply the plastic coating by spraying, dipping, or as a powder.

4. Provide coating thickness at least 125 µm (5 mil).

5. It is not expected that epoxy coated or plastic coated wire bar supports will be completely free of damage. Hanger marks on the coated bar supports, resulting from the coating application process, are acceptable and will not be considered as damaged coating. Make the repair of damaged coating with patching material and according to the material manufacturer's recommendations. The patching material shall be compatible with the epoxy coating material or plastic coating material and be inert in concrete.

6. Furnish a Certificate of Compliance for each shipment of coated wire bar supports.

When permanent corrugated metal forms are used, make the bar supports resting on the metal forms of a dielectric material or coated with a dielectric material whether the reinforcing steel is epoxy coated or not. Epoxy coat reinforcing bars that are used as support bars and resting on the metal forms. Epoxy coat or plastic coat the portion of wire bar supports which are in contact with the metal forms for a distance of at least 19 mm (3/4 in.) from the point of contact.

Position reinforcing in concrete deck slabs on approved metal or plastic supports or chairs or on precast mortar blocks to maintain accurately the specified clearance to the surface of the concrete. Do not space metal support units greater than 1.2 m (4 ft) in either direction when supporting bar sizes No. 16 (#5) and larger. For No. 10 or 13 (#3 or #4) bars, do not space more than 0.9 m (3 ft) in either direction. Do not space plastic or mortar support units greater than 0.9 m (3 ft) in either direction for all bar sizes.

Do not tack weld reinforcing bars, unless authorized in writing.

For reinforcing placement in other than deck slabs, do not space support units (steel, plastic, mortar) more than 1.2 m (4 ft).

Use bar support units sufficient in number and adequate in strength to carry all imposed loads without measurable deflection or displacement of the reinforcing steel. More closely space bar supports than the above maximums as necessary to meet these requirements.

Do not cut reinforcement which has been placed, inspected, and approved unless authorized in writing. Repair any unauthorized cutting of reinforcement satisfactorily. Use approved methods and materials in the repair. Such repair may include complete removal and replacement.

If approved, place any additional reinforcement or other embedded items in the bridge rail to facilitate construction. Epoxy coat additional reinforcement according to Subsection 505.02.03. Use non-corrosive embedded items or protect them by an approved coating.

Design temporary support systems for rebar cages. Submit detailed plans and calculations for examination when requested. If such plans are not satisfactory, make the necessary changes as required until satisfactory results are obtained.

**505.03.05 Splicing.** Furnish all reinforcement bars in the full lengths indicated on the plans. Do not splice bars, except where shown on the plans without written approval. Stagger splices as far as possible. Splice by lapping, welding, or by mechanical splicing. Do not lap splice reinforcing bars No. 43 (#14) and No. 57 (#18).

(a) Lapped Splices. Place the reinforcing bars in contact and wire them together in such a manner as to maintain the alignment of the bars and to provide minimum clearances.

Do not lap splice at locations where the concrete section is not sufficient to provide a minimum clear distance of 50 mm (2 in.) between the splice and the nearest adjacent bar. Do not reduce the clearance to the surface of the concrete.

The required length of lapped splices shall be as shown on the plans.

Overlap sheets of welded wire reinforcement sufficiently to maintain a uniform strength and securely fasten at the ends and edges. Do not edge lap less than one mesh in width.

(b) Welded Splices. Weld reinforcing steel only if detailed on the plans or if given written approval. Welding shall conform to the Structural Welding Code, Reinforcing Steel, AWS D1.4.

A full welded splice shall be welded to develop in tension at least 125% of the specified yield strength of the bar.

A minimum of 15 days before beginning welding, submit 3 copies of procedure qualification records, welding procedure specifications, welders certification and verification of continuous employment, and electrode and wire certifications for approval.

(c) Mechanical Splices. Use mechanical splicing of reinforcing steel only if detailed on the plans or if given written approval.

Mechanical splices may be either the threaded sleeve coupler type, the filler metal sleeve coupler type, or the swaged sleeve coupler type.

A full mechanical connection shall develop in tension or compression, as required, at least 125% of the specified yield strength of the bar.

Use the mechanical connections of approved design. Approval will be based upon technical data, including test results, and other necessary proof of satisfactory performance submitted by the manufacturer. Approval will also be based upon the results of tests which the Engineer may wish to perform on sample splices and splice material furnished by the manufacturer.

Use splicing procedures according to the manufacturer's recommendations. Make splices using the manufacturer's standard and other required accessories.

Squarely cut ends of reinforcing bars to be spliced.

Splice sleeves shall have a clear coverage of not less than 44 mm (1.75 in.) measured from the surface of the concrete to the outside of the sleeve. Adjust or relocate stirrups, ties, and other reinforcement and place additional reinforcement if necessary to provide planned clear coverage to reinforcement.

**505.03.06 Reinforcing Steel (Doweled).** Where called for on the plans, drill holes into existing concrete to the depth shown. The diameter of the drilled holes shall be no more than 6 mm (1/4 in.) larger than the reinforcing bar.

Use any method for drilling the holes, except for core drilling, provided the method selected does not damage the existing concrete and steel reinforcing bars that are to remain.

Exercise care in locating and drilling the holes so as to avoid damage to existing concrete and reinforcing steel bars. Location of the holes may be shifted slightly with approval in order to avoid damaging reinforcing steel. Repair, as directed, any damage caused by operations at own expense.

Before placing epoxy, blow holes clean with dry, oil free compressed air. Pump the epoxy into the holes in such a manner that the back of the holes will be filled first. Use blocking or shimming to center the reinforcing bar in the holes. Place dams at the front of the holes to confine the epoxy, yet permit the escape of air without leaking epoxy. Do not remove dams until the epoxy has cured in the holes.

Use Type IV epoxy conforming to Subsection 728.03.02.

**505.03.07 Substitutions.** Substitution of different size bars or reinforcing materials will be permitted only with specific authorization. The substituted bars or reinforcing shall have an area equivalent to the design area or larger.

## METHOD OF MEASUREMENT

**505.04.01 Measurement.** Reinforcing steel will be measured by the kilogram (pound) and each type, bare or coated, will be considered separately. No additional allowance will be made for the mass of the epoxy coating or for laps added for the Contractor's convenience.

The estimated quantities shown on the plans, plus or minus authorized quantity changes, will be the quantity used for payment. The Engineer or the Contractor may, however, request final measurement. Submit request for final measurement in writing. When final measurement is made, the quantities derived therefrom will be the quantities used for payment.

If the Contractor requests final measurement and the quantities thus determined are equal to or less than the planned quantities plus authorized changes, the Contractor shall reimburse the Department for the Department's expenses incurred by such final measurements.

The calculated masses of the plain and deformed bars will be based on the following:

| Bar Size Metric No. (English #) | Nominal Diameter mm (in.) | Mass kg/m (lb/ft) |
|---|---|---|
| 10 (3) | 9.5 (0.375) | 0.560 (0.376) |
| 13 (4) | 12.7 (0.500) | 0.994 (0.668) |
| 16 (5) | 15.9 (0.625) | 1.552 (1.043) |
| 19 (6) | 19.1 (0.750) | 2.235 (1.502) |
| 22 (7) | 22.2 (0.875) | 3.042 (2.044) |
| 25 (8) | 25.4 (1.000) | 3.973 (2.670) |
| 29 (9) | 28.7 (1.128) | 5.060 (3.400) |
| 32 (10) | 32.3 (1.270) | 6.404 (4.303) |
| 36 (11) | 35.8 (1.410) | 7.907 (5.313) |
| 43 (14) | 43.0 (1.693) | 11.38 (7.650) |
| 57 (18) | 57.3 (2.257) | 20.24 (13.600) |

Reinforcing steel which requires doweling will be measured by the kilogram (pound).

Welded wire reinforcement will be measured by the square meter (square yard) measured along the plane of placement. No allowance will be made for laps.

## BASIS OF PAYMENT

**505.05.01 Payment.** The accepted quantities, measured as provided above, will be paid for at the contract price per unit of measurement for the pay items listed below that are shown in the proposal. Payment will be full compensation for the work prescribed in this Section.

Payment will be made under:

| Pay Item | Pay Unit |
|---|---|
| Reinforcing Steel | Kilogram (Pound) |
| Reinforcing Steel (Epoxy Coated) | Kilogram (Pound) |
| Reinforcing Steel (Doweled) | Kilogram (Pound) |
| Reinforcing Steel (Epoxy Coated) (Doweled) | Kilogram (Pound) |
| Welded Wire Reinforcement | Square Meter (Square Yard) |
| Welded Wire Reinforcement (Epoxy Coated) | Square Meter (Square Yard) |

# SECTION 506

## STEEL STRUCTURES

### DESCRIPTION

**506.01.01 General.** This work consists of furnishing, fabricating, casting, machining or otherwise preparing, transporting, erecting and painting structural steel, steel forgings, castings, deck drains, expansion joint armor, metal covers, sidewalk channels, and other metals.

If there are any conflicts between the requirements contained in the AASHTO/AWS referenced specifications and the requirements of the Standard Specifications, Plans, or Special Provisions, the requirements of the Nevada documents shall govern.

**506.01.02 AISC Certification.** The fabricator of the structural steel shall be certified by the American Institute of Steel Construction's Quality Certification Program. The category of certification shall be as shown on the contract plans. The AISC Certification is required for the fabrication of bridge structures only, and not for the fabrication of deck drains, utility hangers, deck protection angles, pier nose angles or anchor bolt assemblies. Each fabricator shall submit a copy of the certification for the specified category, before or along with the first submittal of shop drawings.

### MATERIALS

**506.02.01 General.** Material shall conform to the following Sections:

| | |
|---|---|
| Structural Steel | Section 710 |
| Miscellaneous Metal | Section 712 |
| Paint | Section 714 |
| Galvanizing | Section 715 |
| Chain-Link Fabric | Section 724 |
| Elastomeric Bearing Pads | Section 725 |

Cut and fabricate steel plates for main members, and splice plates for flanges and main tension members, so that the primary direction of rolling is parallel to the longitudinal axis of the member. Cut and fabricate hinge hanger plates so the primary direction of rolling is perpendicular to the longitudinal axis of the member.

Welded sections may be substituted for the rolled shapes, provided that the shapes and sections to be substituted comply with the following provisions:

(a) Provide depth, width, and average thicknesses at least equal to those for the shape or section shown on the plans.

(b) Weld flanges to web with continuous fillet welds on each side of web, according to Subsection 506.03.16.

(c) Do not reduce the strength classification of the material.

Galvanize anchor assemblies including anchor bolts, nuts, washers, plates and pipes after fabrication according to Section 715.

**506.02.02 Railing.** Galvanize steel bridge rail after fabrication and paint to match the bridge, unless shown otherwise.

Galvanize steel pedestrian rail after fabrication and do not paint.

Do not paint aluminum bridge rail.

For shims for steel railing, use galvanized steel plates. For shims for aluminum railing, use aluminum alloy.

Provide insulating material for insulating the bases of aluminum rail posts from concrete and from steel anchor bolts with an aluminum impregnated light colored caulking compound with the consistency of putty.

Provide bolts, nuts and washers of either galvanized steel, stainless steel, or steel, cadmium plated according to ASTM B766, Class 12, Type III.

CONSTRUCTION

**506.03.01 Shop Drawings.** Shop drawings shall consist of shop detail erection and other working plans showing dimensions, sizes of material, details and other information necessary for the complete fabrication and erection of the metal work. Prepare the drawings on sheets 280 mm (11 in.) by 430 mm (17 in.).

Submit the shop drawings for structural steel for approval. For initial review, submit 3 sets of such drawings for highway bridges. After initial review, submit between 8 and 12 sets as requested for final approval. Submit all shop drawings for approval at least 30 days before planning to start fabrication for highway bridges. When railroad approval is also required, submit for approval at least 90 days before planning to start fabrication for highway bridges. Additional contract time will not be given for working drawings requiring changes and re-submittal.

If electing to furnish bridge rail constructed of aluminum as provided herein and the plan sheets show only steel bridge rail, submit the fabricator's design calculations for verification that the railing and hardware conform to the AASHTO LRFD Bridge Design Specifications.

After approval, do not deviate from the shop drawings without prior approval.

Approval of shop drawings is an acceptance of the character and sufficiency of the details and is not a check of any dimensions. The Engineer's approval of shop drawings will not relieve the Contractor from the responsibility in regard to errors or omissions on said shop drawings.

**506.03.02 Notice of Beginning Work.** Give 15 days written notice of manufacturing of material at the mill so that inspection may be provided. Do not manufacture or begin fabrication of material without authorization.

The Engineer may inspect material, as provided for in ASTM A6. Material not inspected at the place of manufacture is subject to inspection as provided for in Subsection 506.03.03. "Mill" means any rolling mill or foundry where material for the work is to be manufactured.

Before placing the order with the mill, the fabricator shall inquire with the Engineer if additional material will be required for testing. Give 15 days written notice before the beginning of fabrication.

**506.03.03 Inspection and Testing.** All material will be examined and tested as necessary before fabrication. Provide adequate facilities and free access to the necessary work areas. Furnish required test samples free of charge. Material not inspected at the place of manufacture will be subject to all chemical, physical, and workmanship requirements established for the material supplied. Inspection and testing will be by any visual, destructive, or non-destructive method to evaluate the material for its specified properties. Furnish mill orders and certificates, showing test values obtained, in triplicate. Include in certified test reports physical and chemical test results and steel making process used. All steel not identified by mill heat numbers will be rejected.

The Engineer's inspection in the fabrication shop does not relieve the Contractor from responsibility for material or fabrication defects or errors, and the necessity for replacement or correction of rejected materials, and workmanship.

Shop inspection of rail pipe and tubes may be waived and shipment permitted subject to inspection at the project site. The field inspection will cover the general appearance, size, thickness, etc., of the pipe and tubing. Conformance to the requirements of chemical and mechanical properties will also be considered before the material is approved. Shop inspection of rail posts will be made on the first few rail post castings furnished in order to establish a satisfactory class of finish and workmanship. When shop inspection is waived on a portion of the handrail posts, a careful inspection will be made in the field.

Fabricate aluminum alloy material in conformance to or equivalent to fabrication methods and practices recommended in the handbooks of the major producers of aluminum materials and specifically the following requirements:

(a) Saw, route, or mill the material.

(b) Do not flame cut.

(c) Tubing may be heated to a temperature not exceeding 204 °C (400 °F) for a period not exceeding 15 minutes to facilitate bending.

(d) Drill holes in pipe and tubing. Core and ream, or drill holes in castings from the solid. Smoothly finish seats for pipe.

Perform the fabrication and handling of aluminum materials in the shop and field in a manner to prevent scoring or marring of the surfaces. An objectionable appearance resulting from such scoring or marring will be cause for rejection of the material. Fabricate sleeves and rails in lengths indicated on the plans.

Perform the finishing of rail posts after fabrication is completed. Remove all fins, pipes, and other casting irregularities and all drilling, reaming, and other fabrication marks.

**506.03.04 Storage.** Conduct the loading, transporting, unloading, storing, and handling of the structural steel so that the metal is kept clean and free of grease and other foreign material. Place material to be stored above the ground on skids, platforms, or other supports. Properly drain and protect the material from corrosion. Store all material for the project separate from “in stock” materials. Color code different grades or classifications of material as provided for in ASTM A6. Transfer this color code throughout fabrication.

Place girders and beams upright above ground and shore. Support other members such as columns, chords, cross-frames, wind bracing, etc., above the ground on skids placed close enough together to prevent damage from deflections.

**506.03.05 Straightening.** Provide straight rolled material for fabrication. Use methods of straightening according to ASTM A6.

Furnish straight subassemblies and completed members before incorporating into the work. If straightening is necessary, perform by acceptable methods and according to AASHTO/AWS D1.5M/D1.5.

Submit for approval, details of methods proposed for straightening of rolled material, subassemblies, or completed members in writing before their use. In addition, submit a detailed procedure for correcting camber for approval. After straightening or correcting camber, evidence of fracture or other damage will be cause for rejection of the material.

If required, curve beams and girders by either: (1) precutting curved flanges or (2) heat curving the members after fabrication. Heat curve according to Division II, Article 11.4.12 of AASHTO LRFD Bridge Construction Specifications. Submit the procedure to be used for review and approval.

**506.03.06 Punching, Subpunching, Drilling, and Reaming.** For connections and splices (shop and field) of main truss or arch members, continuous beams, plate girders, rigid frames, and web splices, either subpunch (or subdrill) and ream while shop assembled, or drill to full size from the solid while assembled at the shop. Full size punching of holes will be allowed on intermediate stiffeners, bearing stiffeners, cross bracing, wind bracing, and diaphragms.

Do not punch or subpunch structural steel conforming to ASTM A36 on material thicker than 22 mm (7/8 in.) or thicker than 19 mm (3/4 in.) for high strength structural steel. Subpunch holes subpunched for reaming 6 mm (1/4 in.) less in diameter than the finished hole.

Ream or drill holes cylindrically and perpendicularly to the member. Do not oversize or slot holes unless specified on the plans. Direct reamers by mechanical means where practicable. Remove burrs on the outside surfaces. Poor matching of holes will be cause for rejection. Perform reaming and drilling with twist drills.

Unless otherwise specified, assemble each individual (full length) truss, arch, continuous beam or plate girder at the shop before reaming or drilling is commenced. During shop assembly, support all members at such intervals and in such manner as is necessary to avoid undesirable deflections.

Drilling through templates will be permitted only after the templates have been securely placed and firmly clamped or bolted. Securely hold parts together during drilling operations.

Subpunch and ream all holes for floor beams and stringer field end connections to a steel template.

Do not correct mispunched or misdrilled holes by welding, unless approved.

**506.03.07 Bolts and Bolted Connections.** (a) General. Furnish bolts of such length that they will extend entirely through the nut so a minimum of 2 threads are exposed, but not more than 9.5 mm (3/8 in.) beyond.

Make both the bolt head and nut bear squarely against the metal. Drive bolts accurately into the holes without damaging the thread.

Supply bolts with a heavy hexagon head, a circular washer, and heavy hexagonal nut. When slotted or oversize holes are required, or approved for use, place circular washers on each side of the bolted connection and adjust the necessary bolt length accordingly. Provide Direct Tension Indicators (DTIs), when required, in addition to said circular washers.

Fasten all bolted connections, unless otherwise noted, with high strength bolts.

(b) Standard Bolts. Standard bolts shall conform to Subsection 710.03.09. Furnish standard bolts with a single self-locking nut or double nuts, unless otherwise specified.

Use beveled washers where bearing faces have a slope of more than 1:20 (20:1) with respect to a plane normal to the bolt axis.

(c) High-Strength Bolts. 1. General. This subparagraph covers the assembly of structural joints using AASHTO M164 or AASHTO M253 high strength bolts, or equivalent fasteners, tightened to a high tension. Use high-strength bolts with DTIs or use tension control bolts. Give notification of which bolt system is to be used. Use the same bolt system throughout each structure.

The Engineer will sample and test assemblies prior to shipping to the field and will reseal opened containers.

For field bolting, ship bolts, nuts, washers, and DTIs to the jobsite in manufacturer's original unopened containers.

Perform production tests at the jobsite.

2. Bolts, Nuts, and Washers. Bolts, nuts, washers, and tension control bolts shall conform to Subsection 710.03.03. Do not use lock-pin and collar fasteners.

3. Bolted Parts. Fit bolted parts solidly together when assembled and do not separate by gaskets or any other interposed compressible material.

At time of assembly, clean all joint surfaces, including those adjacent to the bolt head, nuts, or washers, of scale, except tight mill scale. Remove burrs, dirt, and other foreign material that would prevent solid seating of the parts.

Do not galvanize high-strength bolts unless shown in the plans.

Paint is permitted on the faying surfaces of bearing-type connections.

The faying surfaces of slip-critical (friction-type) connections shall conform to the following, as applicable:

a. Do not coat faying surfaces except as specified below. Do not apply coating within 25 mm (1 in.) of the connection surfaces. Remove inadvertent overspray by blast cleaning. Once fully assembled, coat the connection as specified.

b. Blast clean faying surfaces of bridge members and coat with the shop coat of paint as specified in Section 614. Do not assemble these connections until the shop coat has fully cured.

c. Hot-dip galvanize faying surfaces specified to be galvanized according to Section 715 and subsequently roughen by hand wire brushing before assembly.

4. Installation.

a. Testing of Individual Components. Before any bolting, each heat or production lot of bolts, nuts, hardened washers, DTIs, and tension control bolts may be sampled and tested as determined by the Engineer. Provide 30 days notice before installation for sampling and testing.

Any samples not meeting the cited specifications will be cause for rejection of the entire heat or production lot. Replace rejected material with materials meeting the specifications.

b. Storage of Material. Store all bolts, nuts, washers, DTIs, and tension control bolts under cover to protect them from rain, snow, dirt, or other adverse conditions. Maintain identification of heat numbers or production lot numbers

with each type of bolting part. Properly lubricate bolting parts. Thoroughly clean any bolt or nut showing rust or weathering and relubricate. Use approved lubricant.

c. Bolt Tension. Install high-strength bolts as herein specified and according to ASTM F959 when using DTIs. Install tension control bolts as specified herein, as recommended by the manufacturer, and as outlined in Division II Article 11.5.6.4.6 of the AASHTO LRFD Bridge Construction Specifications. Tighten each fastener by use of DTIs or tension control bolts to provide at least the minimum bolt tension shown below in Table 1 for the size of fastener used. Do not tighten bolts by calibrated torque wrench methods.

d. Washers. Install a hardened washer under the element (nut or bolt head) turned in tightening. Use hardened washers under both the head and nut regardless of the element turned in the case of AASHTO M253 bolts if the material against which it bears has yield strength less than 275 MPa (40 ksi). Where an outer face of the bolted parts has a slope of more than 1:20 (20:1) with respect to a plane normal to the bolt axis, use a smooth beveled washer.

e. Installation. Locate the DTI under the head with the nut being the turned element. When required and when approved, other bolt assembly configurations may be used, as shown in Figure 1 of ASTM F959. Locate nuts, whenever practicable, on the side of the member which will not be visible from the traveled way. Locate nuts for bolts that will be partially embedded in concrete on the side of the member that will be encased in concrete.

f. Production and Procedure Testing. Just before initial bolting operations or when directed, perform bolt system testing. Assemble a representative sample of not less than 3 bolts for each diameter, grade and lot number in a Skidmore-Wilhelm testing machine. The test assemblies shall include a bolt, nut, and washer(s).

If required bolt tension with the DTI installation or tension control bolts cannot be verified with the testing procedure, then stop the bolting operations until satisfactory corrective action has been taken.

Calibrate and certify the Skidmore-Wilhelm testing machine by an approved testing lab within 30 days before use. Supply the fully certified Skidmore-Wilhelm testing machine for testing.

g. Final Bolting. Before final tightening, tighten the connection to a snug tight condition. Snug tight shall be defined as all bolts tightened with hand wrenches until the connection is tight with no gaps. Commence final tightening from the middle of the connection working outward. If required because of bolt entering and wrench operation clearances, tightening may be done by turning the bolt while the nut is prevented from rotating. Provide impact wrenches, if used, of adequate capacity and sufficient air supply to perform the required tightening of each bolt within 10 seconds.

Do not reuse AASHTO M253 (A490) or galvanized AASHTO M164 (A325) bolts. Other AASHTO M164 bolts may be reused, but not more than once, if approved. Retightening previously tightened bolts which may have been loosened by the tightening of adjacent bolts will not be considered as a reuse.

Locate the DTI at the opposite end of the bolt from the part being tightened where possible. When the DTI is used next to a slotted or oversized hole, place a hardened flat washer between the DTI and the bolt hole. When the DTI must be placed at the part being tightened, place a hardened flat washer between the DTI and the part being tightened. Tension bolts using DTI in accordance with the manufacturer's instructions. Do not reuse the DTI after tension has been applied to the bolt.

All bolting and testing operations will be inspected in order to determine that the approved installation procedure is utilized and that the correct tension has been achieved. All bolting and testing operations completed without the presence of the Engineer will be cause for rejection.

**TABLE 1**
**Minimum Bolt Tension [1]**

| Nominal Bolt Diameter [2] mm (in.) | AASHTO M164 Bolts kN (lb) | AASHTO M253 Bolts kN (lb) |
|---|---|---|
| 16 (5/8) | 85 (19,000) | 107 (24,000) |
| 19 (3/4) | 125 (28,000) | 156 (35,000) |
| 22 (7/8) | 173 (39,000) | 218 (49,000) |
| 25 (1) | 227 (51,000) | 285 (64,000) |
| 29 (1 1/8) | 249 (56,000) | 356 (80,000) |
| 32 (1 1/4) | 316 (71,000) | 454 (102,000) |
| 35 (1 3/8) | 378 (85,000) | 538 (121,000) |
| 38 (1 1/2) | 458 (103,000) | 658 (148,000) |

[1] Equal to 70% of specified minimum tensile strength of bolts.
[2] Metric diameters are nominal sizes based on English bolt sizes.

**506.03.08 Shop Assembly.** Perform shop assembly of trusses, arches, continuous beams, plate girders, and rigid frames according to Subsection 506.03.06. Match mark all members before disassembly.

Fabricate straight and close fitting component parts for built-up members.

Clean surfaces of metal in contact before assembling. Assemble, pin, and firmly draw together the parts of a member with bolts before drilling and reaming. Take apart assembled pieces, if necessary, for the removal of burrs and shavings produced by the operation. Provide members free from twists, bends and other deformations.

Perform drifting during assembling only to bring the parts into position, and not to enlarge the holes or distort the metal.

Match mark connecting parts in the shop for the purpose of reaming holes in field connections, and furnish a diagram showing such marks.

Furnish a camber diagram showing the camber at each panel point in the cases of trusses, and at field splices and 1/10 points of span for beams, girders, and rigid frames. The final camber will be checked on the fully assembled girders in the “no load” position for rolled beams and I-plate girders, and in the “dead load” position for box plate girders. The bolts in the field splice need not have the final tension applied. Apply only enough tension to adequately keep the assembled section together for the camber measurements.

Before fabrication, submit a handling procedure for box plate girders for approval. Propose procedure that applies no undue stresses to the flange to web welds.

**506.03.09 Edge Planing.** Plane the sheared edges of plates more than 16 mm (5/8 in.) in thickness and carrying calculated stress to a depth of 6 mm (1/4 in.). Fillet re-entrant cuts to a radius of 19 mm (3/4 in.).

**506.03.10 Facing of Bearing Surfaces.** The surface finish of bearing and base plates and other bearing surfaces that are to come in contact with each other or with concrete shall meet the following American National Standards Institute surface roughness requirements as defined in ANSI B46.1, Surface Roughness, Waviness and Lay, Part 1:

| | |
|---|---|
| Steel slabs | ANSI 50 μm (2,000 μin.) |
| Heavy plates in contact in shoes to be welded | ANSI 25 μm (1,000 μin.) |
| Milled ends of compression members, stiffeners, and fillers | ANSI 13 μm (500 μin.) |
| Bridge rollers and rockers | ANSI 6 μm (250 μin.) |
| Pins and pin holes | ANSI 3 μm (125 μin.) |
| Sliding bearings | ANSI 3 μm (125 μin.) |

**506.03.11 Abutting Joints.** Mill abutting joints in compression members of trusses and in columns.

Do not exceed 6 mm (1/4 in.) openings in abutting joints in tension members.

Do not exceed 6 mm (1/4 in.) openings in abutting joints of rolled beams, plate girders, and box plate girders.

**506.03.12 Thermal Cutting.** Perform this work according to AASHTO/AWS D1.5M/D1.5. Do not perform plasma arc cutting in shop fabrication unless approved. Perform hardness testing of cut edges as directed.

**506.03.13 End Connection Angles.** Build floor beams, stringers, and girders having end connection angles to exact length shown on the plans measured between the heels of the connection angles, with a permissible tolerance of + 0 mm to – 1.5 mm (+ 0 in. to – 1/16 in.). Where continuity is to be required, face end connections. Use connection angles not less than 9.5 mm (0.375 in.) thick, nor less than that shown on the detail drawings.

**506.03.14 Lacing Bars.** Neatly round the ends of lacing bars unless another form is required.

**506.03.15 Shear Stud Connectors.** Provide shear stud connectors of a design suitable for end welding and end weld to steel beams, girders, or plates with automatically timed stud welding equipment. The type, size or diameter, and length of stud shall be as specified in the contract documents. See AASHTO/AWS D1.5M/D1.5 for allowable tolerances. Do not exceed a maximum variation of 25 mm (1 in.) from the location shown provided the adjacent studs are not closer than 63 mm (2.5 in.) center to center. Maintain a clear distance between the edge of a girder flange and the edge of the shear connectors of not less than 25 mm (1 in.). Make adequate provisions in the fabrication of structural members to compensate for loss of camber due to welding of the shear connectors.

Do not paint or galvanize studs. Remove rust, scale, rust pits, and oil from the studs at the time of welding and immediately before the concrete is placed. Remove excessive mill scale, rust, dirt, paint, grease, or any other material which might impair the quality of the weld to the beam surface. When necessary to obtain satisfactory welds, wire-brush, peen, prick-punch, or grind free of scale or rust.

Submit for approval, before installation, information on the studs to be furnished as follows:

(a) The name of the manufacturer.

(b) Detailed description of the stud and arc shield.

(c) A certification from the manufacturer that the stud is qualified as specified in AASHTO/AWS D1.5M/D1.5. The certification must also indicate the heat from which the studs were manufactured.

Welding specifications and procedure requirements shall conform to AASHTO/AWS D1.5M/D1.5.

**506.03.16 Welding.** (a) General. Submit 3 copies of the following items, for approval, a minimum of 15 days before beginning fabrication:

1. Procedure qualification records.
2. Welding procedure specifications.
3. Welders qualification list, certification record and verification of continuous employment.
4. Electrode and wire certifications.
5. Mill certifications.

Perform all welding in the fabrication shop, except as otherwise noted on the plans or permitted.

Use automatic welding for all flange to web welds.

Limit shop splices of flanges or webs of main members to locations where section changes occur, where shown on the plans, or as approved.

The welds in butt splices of both webs and flanges shall be inspected and found satisfactory before performing web to flange connections.

Limit field splices to the actual locations shown on the plans.

Additional field or shop splices, may be used, if reviewed and approved in writing before fabrication.

Weld in conformance to AASHTO/AWS D1.5M/D1.5, except do not use electro slag welds.

Finish groove welds on primary members smooth and flush with the base metal on all surfaces by grinding in the direction of applied stress, leaving surfaces free from depressions.

Use extension bars or runoff tabs at the end of a joint in a manner that will ensure sound welds.

Terminate fillet welds on stiffeners or gusset plates 6 mm (1/4 in.) from the end of the plate or cope.

The minimum length of welds shall be 50 mm (2 in.).

Weld structural steel only at locations shown on the shop drawings, including tack welds. Do not weld lifting lugs or attachments.

The fabricator shall submit for review all welding procedures for prequalified welds. The Engineer may test any prequalified weld.

Do not place shear stud connectors on shop splices, move studs up to 75 mm (3 in.) either side of the splice if a conflict occurs.

Where welds in both the web and flange fall at the same location, offset them a minimum 150 mm (6 in.). When a stiffener falls at a location of a flange or web weld, offset the stiffener a minimum 75 mm (3 in.) from the weld.

Upon approval, shop splices may be located at points that are consistent with lengths of plate available from the mill and in areas of reduced tensile stress. To eliminate shop splices, the length of a thicker plate may extend to the end of a thinner plate or the end of a member. Show these changes if approved on the shop drawings.

(b) Inspection-Testing. All shop and field welds will be inspected to the provisions of AASHTO/AWS D1.5M/D1.5 and these specifications.

Visually inspect all welds and test welds according to this Subsection. The Engineer will make the final evaluation of the acceptability of all welds.

(c) Quality Control. Submit, in writing, a quality control program. The program shall outline the quality control tasks to be performed to insure that the work conforms to the plans and these specifications. The quality control program shall also identify the Contractor's personnel who will be responsible for performing the quality control tasks.

The quality control program must be approved in writing before the start of any fabrications.

(d) Supervision. Provide adequate supervision and inspection of all welds to ensure satisfactory, consistent and uniform workmanship. Repeated and chronic weld defects will be considered as evidence that proper quality control and supervision procedures are not being provided.

Provide quality control inspectors at all times during fabrication, including alternate shifts.

(e) Time of Inspection. Provide visual inspection continuously. Begin nondestructive testing of welds immediately after welding operations are completed, except for ASTM A514 and A517 steels. Do not perform final nondestructive testing of welds for ASTM A514 and A517 steels until at least 96 hours have elapsed after completing welding operations. All nondestructive testing shall be performed in the presence of the Engineer or a representative designated by the Department.

(f) Heat Numbers. Transfer heat numbers of all plates separated into flange and web sections through steel stamping immediately after stripping at the burn table.

(g) Visual Inspection of Welds. Use inspection requirements and standards for visual acceptance as stated in AASHTO/AWS D1.5M/D1.5. Visually inspect and accept welds, and make any required repairs, before performing any nondestructive testing for acceptance.

(h) Testing Precedence. When both radiographic inspection and ultrasonic inspection are to be performed on a weld, perform radiographic inspection before ultrasonic inspection except in flanges where acceptance is based on ultrasonic method.

(i) Radiographic Inspection. Perform all radiographic testing and inspection.

1. Licensing Requirements. Use an agency to perform the radiographic testing which is currently licensed for the operation involving radioactive materials under the proper jurisdiction where such inspection is performed.

2. Testing Procedures Submittal. Before beginning fabrication of structural steel components, submit in writing for approval, a copy of proposed radiographic test procedures.

3. Résumé. Furnish a résumé listing the specific radiographic equipment and outlining the particular radiographic procedures proposed for use. Furnish a statement detailing the radiographic training and experience for each person to be employed in radiographic testing, and certify that each of these persons meets the qualification requirements of paragraph 6.1.3.4 of AASHTO/AWS D1.5M/D1.5. Only those personnel approved in writing shall perform radiographic inspection.

4. Scheduling. Schedule radiographic testing and give not less than 12 hours notice in advance of the scheduled time and place for this testing, the items to be radiographed, and the radiographic agency to be utilized unless otherwise authorized. Schedule radiographic testing during daylight hours unless requested in writing and approved. Blanket approval for an extended period may be given.

Do not radiographically inspect butt welds in girder flanges and webs until the girder flange or web section is cut to its finished width.

5. Extent of Inspection.

a. Groove Welds. Furnish radiographs, and radiographic reports for welds as follows:

Welds to be tested will be selected. Test 100% of each weld selected. Test 10% of the total number of tension flange welds, 5% of the total number of compression flange welds and 10% of the total number of web splices. Consider flanges not identified on the design drawings as being in compression to be in tension, including flanges subject to reversal stresses.

If defects are disclosed in the radiographs, repair weld defects and repeat radiographic inspection and reevaluate the area with ultrasonic inspection. These welds may also be reevaluated by Department personnel. Repair any defects disclosed by ultrasonic reevaluation. Repaired defects shall be evaluated by both radiographic and ultrasonic inspection performed in accordance with AASHTO/AWS D1.5M/D1.5.

b. Additional Radiographic Inspection. The Engineer may perform radiographic inspection in addition to such inspection performed by the Contractor. Make available the facilities used in the operations for use by the Engineer in performing such additional inspection. Repair any defective welds and repeat radiographic inspection.

6. Radiographic Procedure.

a. Requirement. Use a radiographic procedure conforming to ASTM E94, and these specifications.

Use edge blocks when radiographing butt welds greater than 12.5 mm (1/2 in.) thick. Provide edge blocks of a length sufficient to extend beyond each side of the weld centerline for a minimum distance equal to the weld thickness, but no less than 50 mm (2 in.), with a thickness equal to or greater than the thickness of the weld. The minimum width of the edge blocks shall be equal to half the weld thickness, but not less than 25 mm (1 in.). Center the edge blocks on the weld with a snug fit against the plate being radiographed, allowing no more than 1.5 mm (1/16 in.) gap. Make edge blocks of radiographically clean steel and with a surface finish of ANSI 3 μm (125 μin.) or smoother.

b. Film. Radiograph on material whose thickness is 23 mm (0.901 in.) or less on Type I industrial radiographic film. Radiograph on material whose thickness is greater than 23 mm (0.901 in.) to 89 mm (3.5 in.) on Type II industrial radiographic film. Use radiographic film conforming to ASTM E94. Use film wide enough to fully span the width of the weld with sufficient excess to allow the specified location markers and other identification to show on the film outside of the weld area, but in no case use film less than 110 mm (4.5 in.) in width, and 430 mm (17 in.) in length. The testing agency conducting the radiograph shall submit for approval all data concerning the film, including brand name and type, before any radiograph being performed.

c. Process and Detail. Make radiographs by either X-ray or gamma ray. All radiographs shall determine quantitatively the size of defects having thickness equal to or greater than 2% of the thickness of the thinner of the parts joined by the weld under examination. Use clean radiographs, free of film processing defects, and with densities of not less than 2.0 nor more than 4.0 in the area of interest. Do not use a gamma ray source which exceeds 4 mm (0.16 in.) across its greatest diagonal dimension to radiograph welded material up to 75 mm (3 in.) in thickness.

Radiographs shall show the following:

(1) The essential hole in each penetrameter as specified in AASHTO/AWS D1.5M/D1.5.
(2) The penetrameter identification number.
(3) The radiograph identification and location marks indicated below under “Identification and Location Marks.”

d. Film Development. Develop radiographic film within the time and temperature range recommended by the film manufacturer. Do not sight develop. Manually hot air dry the film. Do not use automatic driers.

e. Dual Film Technique. In the event that the greatest and least thickness of a weld joining parts of different thicknesses cannot both be rendered with a single exposure on a single film having densities within the limits specified under “Process and Detail,” use a dual film or dual exposure technique. Calibrate these techniques to obtain the required density for both the greatest and the least thickness of the weld. When these techniques are employed use 2 extra penetrameters in addition to the 2 specified under “Penetrameters.” Position the 4 penetrameters so that at least one penetrameter image appears at each end of each film on the plate thickness for which that film has been exposed.

f. Penetrameters. Use 2 or more penetrameters for each radiograph according to AASHTO/AWS D1.5M/D1.5.

g. Radiographic Exposure. Make radiographs with a single source of radiation approximately centered with respect to the length of the weld being examined. Maintain a perpendicular distance from the radioactive source to the film of not less than 7 times the maximum thickness of the weld under examination. Do not penetrate the weld with rays at an angle greater than 26.5° from a line perpendicular to the weld surface. During exposure, place the film at the opposite side to the source of radiation and as close to the surface of the weld as possible.

7. Identification and Location Marks.

a. Fabrication. Radiographic identification for inspection of welds shall consist of the following:

(1) State Contract Number.

(2) Weld Identification Number. The weld identification number shall consist of a sequence of digits conforming to the following:

(a) The fabrication number of the girder in which the radiographed weld occurs, followed by a dash (-).

(b) Letter combination designating the section in which the radiographed section occurred. Designate the section by the letters TF (Top Flange), BF (Bottom Flange), or the word Web.

(c) The joint designation consisting of the letter W preceded by a space and followed by a number. The number shall designate the joint in which the radiographed weld occurs and shall correspond to the number of welded joints between the reference or work end of the section and the radiographed weld.

(d) Steel stamp all weld identification numbers.

(3) Identification of the company performing the radiograph.

(4) Radiographer's initials.

(5) Six numeric digits indicating "Month"–"Day"–"Year."

b. Erection. Radiograph identification for radiographs of welds performed after erection will be as designated.

c. Repairs. Suffix the weld identification number on radiographs of repaired welds with the letter R and a number showing how many times the weld has been repaired.

d. Radiograph Location Marks. When complete radiographic coverage of a weld is specified, locate or place other supplementary match marks to appear on the film according to Section 14 of ASTM E94. Radiograph location marks will not be required for radiographs made at field construction sites. Indicate the location of radiographs made at field construction sites by a number added to the end of the weld identification number. Separate such a number, from the joint or splice number by a space, signifying the location of radiographs on plate girder joints or splices when viewed ahead on line, as follows:

1 = right side bottom flange
2 = left side bottom flange
3 = left side top flange
4 = right side top flange
5 = web adjacent to top flange

In the event additional radiographs of a given web weld are required, identify these as consecutive location numbers starting with 7. The exact location of such radiographs shall be approved and noted in the radiographic reports.

e. Radiographic Identification (Miscellaneous). Establish an approved radiograph identification and marking system for welds on other than plate girder structures before radiographic inspection begins.

8. Examination. Reports and Disposition of Radiographs.

a. Viewer. Provide a suitable high-intensity radiograph viewer at the place where radiographic inspection is performed.

b. Acceptance. Before acceptance of a weld subject to radiographic inspection, submit radiographs, including any that show unacceptable quality before repair, and a report interpreting them.

c. Reports. Submit 3 copies of the radiographic report showing the results of radiographic tests performed during each shift. Include the following information in the radiographic report:

(1) Date

(2) Name and address of the radiographic inspection agency.

(3) Description of structure being inspected.

(4) Location of structure or fabrication site.

(5) Contract number.

(6) Specification being used to accept or reject welds radiographically inspected.

(7) Name and address of the fabricator.

(8) Radioactive source, type and size (either current or dated strength), or X-ray unit type and size.

(9) Type of film used.

(10) Names of technicians performing the radiograph.

(11) NDT numbers for the reported radiographs.

(12) Weld identification number for each radiograph.

(13) Item radiographed (flange, web, etc.) for each radiograph.

(14) Thickness of the item radiographed for each radiograph.

(15) Distance from the radioactive source or focal spot to the film for each radiograph.

(16) An interpretation of each radiograph providing an analysis of:

(a) Cracks.
(b) Porosity or gas holes.
(c) Slag or inclusion.
(d) Lack of fusion.
(e) Incomplete penetration.

(17) Acceptability of both weld and radiograph for each radiograph.

(18) Remarks (if any) concerning any unusual observation or condition in the weld or radiograph.

(19) Radiographer’s signature.

d. Packaging. Package radiographs and reports in suitable envelopes and clearly mark on the outside with the following identification:

(1) Contract number.

(2) Fabricator.

(3) NDT report numbers for the radiographs in the package.

e. Disposition of Reports. After review and approval of radiographic reports the original and 2 copies of the reports together with the radiographs will be retained.

(j) Ultrasonic Inspection of Welds.

1. General. Use inspection methods as provided for in AASHTO/AWS D1.5M/D1.5.

2. Résumé. Furnish a résumé listing the specific ultrasonic equipment and outlining the particular ultrasonic procedures proposed. Furnish a statement detailing the ultrasonic training and experience for each person to be employed in ultrasonic testing, and certify that each of these persons meets the qualification requirements of paragraph 6.1.3.4 of AASHTO/AWS D1.5M/D1.5. Only those personnel approved in writing shall perform ultrasonic inspection.

3. Extent of Ultrasonic Inspection:

a. Perform ultrasonic inspection on 100% of the total weld length of all full penetration welds in web splices and flange splices.

b. For full penetration welds in web to flange connections, ultrasonically inspect 25% of the length of each weld subject to tension and 10% of the length of each weld subject to compression. If this inspection discloses defective welds, check 300 mm (12 in.) of additional weld on each side of the test area. If defects occur in these areas, check 100% of the remaining weld. Areas to be tested will be selected.

c. Test 25% of miscellaneous full penetration welds as selected by the Engineer.

d. Acceptable welds will be verified by ultrasonic inspection. Inspection will be on 10% of tension flange welds, 10% of web splices, and 5% of compression flange welds. If such inspection discloses defective welds, additional inspection may be required. Repair defective welds.

4. Scheduling of Inspection. Give written notification at least 6 hours in advance of scheduled ultrasonic inspection.

5. Weld Preparation. Do not schedule ultrasonic inspection of welds until welds have been prepared as follows:

a. Remove any back-up plates and run-off tabs.

b. Grind welds flush and smooth with a maximum roughness not to exceed 6 μm (250 μin.) rms.

c. Leave off all shear studs, brackets, bolt holes, and other projections or obstructions within the scanning zone until ultrasonic inspection has been completed and the welds accepted.

d. Remove loose mill scale, rust, dirt, paint, grease, oil, grime, weld splatter, etc. from the scanning zone.

6. Inspection Procedures. Perform ultrasonic inspection and evaluation as follows:

a. Perform ultrasonic inspection and evaluation only during the regular hours for each shift unless otherwise allowed.

b. Do not perform ultrasonic inspection and evaluation at unsafe locations or locations not readily accessible.

c. Do not perform ultrasonic inspection in the presence of rain, snow, or blowing sand, or when the wind velocity exceeds 16 km/hr (10 mph), except under approved shelter.

d. Perform ultrasonic inspection and evaluation only when the temperature of the steel is between 4 °C (40 °F) and 49 °C (120 °F).

e. Before the initiation of ultrasonic inspection, visually inspect joints for surface defects and conformance to joint preparation requirements.

7. Include the following in Ultrasonic Test reports:

a. Date.
b. Contract No.
c. Fabricator.
d. Description of structure being inspected.

e. Material thickness.
f. Weld identification.
g. Transducer angle.
h. Reference level.
i. Defect level.
j. Attenuation factor.
k. Defect rating.
l. Length of defect.
m. Angular distance.
n. Depth from surface.
o. Distance from reference point.
p. Type of defect.
q. Either accepted or rejected.
r. Name & level of technician performing inspection.

Upon completion of ultrasonic inspection, submit the original and 2 copies of the test report for inspection performed on each shift.

(k) Dye Penetrant Inspection of Welds. If directed, perform dye penetrant inspection according to AASHTO/AWS D1.5M/D1.5.

(l) Magnetic Particle Inspection of Welds.

1. General. Perform magnetic particle inspection, including weld preparation. Use inspection methods as provided for in AASHTO/AWS D1.5M/D1.5.

2. Résumé. Furnish a résumé listing the specific magnetic particle equipment and outlining the particular magnetic particle procedures proposed. Furnish a statement detailing the magnetic particle training and experience for each person to be employed in magnetic particle inspection, and certify that each of these persons meets the qualification requirements of paragraph 6.1.3.4 of AASHTO/AWS D1.5M/D1.5. Only those personnel approved in writing shall perform magnetic particle inspection.

3. Perform inspection as outlined in AASHTO/AWS D1.5M/D1.5 paragraph 6.7.2 through 6.7.2.3.

4. Scheduling of Inspection. Give written notification at least 6 hours in advance of scheduled magnetic particle inspection.

(m) Marking of Welds for Repair. Mark defective welds in the presence of the Engineer on the surface and side in which the repair will be made. Clearly mark the length and depth of the defect. Note defect length by a line on the surface directly over the defect. Mark (outside the weld area) the depth from the noted surface with a suitable line or arrow referencing the applicable defect.

(n) Allowable Number of Repairs. When any weld has been repaired 3 times and rejected 4 times, hardness tests will be performed. Acceptable values will be determined by the Department's Materials Division for weld metal and the heat affected zone depending on the type of base metal. If the hardness values exceed the permissible range, completely remove the weld and heat affected material.

(o) Excessive Welder/Operator Repairs. A full penetration weld repair incident shall be considered as the required repair of any portion of a full penetration weld due to nonconformance with AASHTO/AWS D1.5M/D1.5. Multiple rejects in a single full penetration weld shall be considered as 1 repair incident. A welder/operator shall be limited to 4 repair incidents out of every 16 full penetration welds completed. In the event a welder/operator exceeds this repair rate, the following measures shall be taken:

1. The welder/operator shall be restricted from performing further work on the project until an evaluation of the weld defects and welding equipment is conducted and a determination is made as to the root cause of the excessive defects.

2. The welder/operator may be subjected to additional training and qualification testing depending on the determination of the root cause of excessive defects. The welder/operator shall not return to the project until given approval.

**506.03.17 Fit of Stiffeners.** Fit stiffeners as specified in AASHTO/AWS D1.5M/D1.5.

**506.03.18 Annealing and Stress Relieving.** Perform annealing and stress relieving as specified in Division II, Article 11.4.11 of the LRFD Bridge Construction Specifications.

**506.03.19 Pins, Rollers, and Pin Holes.** Rollers shall be of structural carbon steel and pins shall be of carbon steel forgings meeting the requirements of Subsection 710.03.08. Accurately turn pins and rollers to the dimensions shown on the drawings and make straight, smooth, and free from flaws. Produce final surface by a finishing cut.

In pins larger than 225 mm (9 in.) in diameter, bore a hole not less than 50 mm (2 in.) in diameter full length along the axis. Bore hole after the pin has been cooled to a temperature below the critical range under suitable conditions to prevent injury by too rapid cooling, and before being annealed.

Bore pin holes true to the specified diameter, smooth and straight at right angles with the axis of the member and parallel with each other.

Do not vary the distance outside to outside of holes in tension members and inside to inside of holes in compression members from that specified by more than 0.80 mm (1/32 in.). Perform boring of holes in built up members after the bolting is complete.

Bore diameter of the pin hole not exceeding that of the pin by more than 0.50 mm (1/50 in.) for pins 125 mm (5 in.) or less in diameter, or more than 0.80 mm (1/32 in.) for larger pins.

Screw threads for all bolts and pins for structural steel construction shall conform to the American National Coarse Thread Series, Class 2, free fit, except thread pin ends having a diameter of 34 mm (1.375 in.) or more at 6 threads per 25 mm (1 in.).

Furnish and use pilot and driving nuts in driving pins. Furnish 2 pilot nuts and 2 drifting nuts for each size of pin. Drive pins so that the members will take full bearing on them. Screw pin nuts up tight and burr the threads at the face of the nut with a pointed tool.

**506.03.20 Shop Painting.** Apply shop paints in conformance with Section 614.

Use equipment and methods of handling materials which prevent marring or damage to the shop coat of the painting system. Insulate the steel from lifting chains or cables by approved softeners. Pad hooks, clamps and slings used to hoist steel. Repair shop coated paint surfaces that are marred or damaged with materials and to a condition of the coating as specified in Section 614.

**506.03.21 Marking and Shipping.** Permanently stamp each member with an erection mark for identification and furnish an erection diagram with erection marks shown thereon. Do not use painted erection marks. Mark the mass on members weighing more than 2.7 metric ton (3 ton). Load structural members on trucks or cars so that they may be transported and unloaded at their destination without being excessively stressed, deformed or otherwise damaged. Ship girders in a vertical position and maintain vertical in subsequent operations, or as approved.

**506.03.22 Erection Methods and Equipment.** At least 15 days before the start of erection, give written notice as to the method of erection proposed, and as to the amount and character of the equipment proposed, the adequacy of which will be subject to approval. Perform storage and handling of the beams or girders on the erection site in conformance to Subsections 506.03.04 and 506.03.08. Do not consider the approval as relieving the responsibility for the safety and adequacy of methods or equipment or from carrying out the work in full accordance with the plans and specifications.

Do not spot weld for the purpose of eliminating field erection bolts or for holding steel parts together while bolting.

Erection work will be subject to inspection. Furnish facilities for such inspection of material and workmanship. Furnish a man lift or erect an approved platform to provide the Engineer access for inspection during erection. Material and workmanship not previously inspected will be inspected after its delivery to the site of the work.

Provide falsework, tools, machinery and appliances, including drift pins and fitting up bolts, necessary for the expeditious handling of the work.

Use galvanized high-strength bolts for rail post anchor bolts. Set anchor bolts with suitable templates in exact position and securely fix to prevent displacement during the concreting operations. Dress the areas of concrete upon which posts are to be set by grinding and rubbing to a true plane for the proper seating of the posts. Coat surfaces of aluminum alloy posts and adjustment shims to be in contact with concrete or with the steel anchor bolts, nuts, and washers with aluminum insulating compound.

Erect rail posts in sections. Continue erection of sections of rails and posts successively. Align the rail and tighten the nuts on the anchor bolts. Do not deviate posts more than 3 mm (1/8 in.) from true alignment and do not create an abrupt break in alignment at any location. Aluminum shims may be slotted for ease in placing if approved.

Use equipment and erection methods which prevent marring or damage to the shop coat of the painting system. Insulate the steel from lifting chains or cables with approved softeners. Pad hooks, clamps, and slings used to hoist steel. Repair all shop coated paint surfaces that are marred or damaged, with materials and to a condition of the coating as specified in Section 614.

**506.03.23 Falsework.** Properly design the falsework and substantially construct and maintain for the loads which come upon it. Prepare and submit for approval, plans for falsework or plans for changes in an existing structure necessary for maintaining traffic. Do not consider approval as relieving the Contractor of any responsibility.

Show holes for falsework and forms on the shop drawings and drill in the shop before any application of paint. Locate holes such that distortion of the web shall not occur. Use temporary ties and struts when necessary to resist lateral loads and control relative deflections.

Limit welding of falsework supports to compression flanges only, as approved.

Upon completion of the erection and before final acceptance, remove all falsework, excavated or useless materials, rubbish and temporary buildings. Replace or renew any fences damaged, restore in an acceptable manner all property, both public and private, which may have been damaged during the prosecution of the work, and leave the structure site and adjacent highway in a satisfactory neat and presentable condition.

Remove excavated material or falsework placed in the stream channel before final acceptance.

When directed and when applicable, remove and dispose of temporary crossframes between box plate girders.

Pad materials used for falsework and forms, and their supporting members, which may bear against the shop coated paint of steel members. Insulate overhang jacks and other deck support systems along with their connections from the shop coated paint. Do not use metal rollers, clamps, and other types of fasteners which will mar or damage shop coated surfaces. Repair shop coated paint surfaces that are marred or damaged, with materials and to a condition of the coating as specified in Section 614.

**506.03.24 Bearing and Anchorage.** Set bridge bearings in exact position as shown on the plans and with full and even bearing on the masonry. Do not place bridge bearings on masonry bearing areas which are irregular or improperly formed.

Give surfaces designed for sliding movement, one upon the other, a field coat of graphite grease when placed in the structure.

Drill the holes and set the anchor bolts, except where the holes are formed or the bolts are built into the masonry. Set the bolts accurately and fix with Portland cement grout, completely filling the holes. Adjust the location of the anchor bolts in relation to the slotted holes in the expansion shoes to correspond with the temperature at the time of erection. Adjust the nuts on anchor bolts at the expansion ends of spans to permit free movement of the span.

Elastomeric bearing pads shall conform to Subsection 502.03.14 and Section 725.

**506.03.25 Field Assembly.** If the contract covering the erection of the steel does not include the fabrication, check the material received and report promptly, in writing, any shortage or injury discovered. Accurately assemble the parts as shown on the plans and follow match-marks. Carefully handle the material so that no part will be bent, broken, or otherwise damaged. Do not injure or distort the members by hammering. Clean bearing surfaces and surfaces to be in permanent contact before the members are assembled.

Unless erected by the cantilever method, erect truss spans on blocking to give the trusses proper camber.

**506.03.26 Misfits.** Consider the correction of minor misfits involving nonharmful amounts of reaming, cutting and chipping a legitimate part of the erection. Immediately report any error in the shop fabrication or deformation resulting from handling and transportation which prevents the proper assembling and fitting up of the parts. The moderate use of drift pins or a moderate amount of reaming and slight chipping or cutting will be allowed. Obtain approval for the method of correction. Make the necessary corrections and replacements in presence of Engineer.

**506.03.27 Field Painting.** Paint structural steel as specified in Section 614.

METHOD OF MEASUREMENT

**506.04.01 Measurement.** Structural steel will be measured by one of the methods specified herein.

(a) Kilogram (Pound) Basis. When specified, structural steel will be measured by the kilogram (pound). The estimated quantities shown on the plans, plus or minus authorized quantity changes, will be the quantity used for payment. The Engineer or the Contractor may, however, request final measurement. Submit request for final measurement in writing. When final measurement is made, the quantities derived therefrom will be the quantities used for payment.

The calculated mass will be based on the following assumptions:

1. Unit masses, kg/m$^3$ (lb/ft$^3$):

| | |
|---|---|
| Iron, malleable | 7,530 (470) |
| Iron, wrought | 7,800 (487) |
| Steel, rolled, cast, copper bearing, silicon, nickel and stainless | 7,850 (490) |

   Additional mass due to substitutions made at the Contractor's request will not be included.

2. The mass of bolts, cap screws, anchor bolts, nuts, washers and anchor pipe sleeves remaining in the finished structure will be computed on the basis of their nominal mass and dimensions.

3. The mass of paint will not be included in the computed mass of metals.

4. The mass of weld metal will be computed on the basis of the theoretical volume of the dimensions of the welds.

(b) Lump Sum Basis. When specified, structural steel will be measured by the lump sum. The lump sum price shall include all metal in the finished structure including but not limited to bolts, nuts and washers, stud connectors, scuppers and deck drains, castings, pier nose angles, expansion joint angles and supports, plain elastomeric bearing pads, plates, anchorages, welding materials, and galvanizing. There will be no change in measurement due to substitutions made at the Contractor's request.

(c) Linear Meter (Linear Foot) Basis. When specified, bridge rail or pedestrian rail will be measured by the linear meter (linear foot) of rail.

BASIS OF PAYMENT

**506.05.01 Payment.** The accepted quantities, measured as provided above, will be paid for at the contract price per unit of measurement for the pay items listed below that are shown in the proposal. Payment will be full compensation for the work prescribed in this Section.

Payment will be made under:

| **Pay Item** | **Pay Unit** |
|---|---|
| Structural Steel | Kilogram (Pound) or Lump Sum |
| Bridge Rail (type) | Linear Meter (Linear Foot) |
| Pedestrian Rail (type) | Linear Meter (Linear Foot) |

# SECTION 508

## DRIVEN PILES

DESCRIPTION

**508.01.01 General.** This work consists of furnishing and driving piles.

**508.01.02 Submittals.** Submit the following information for review and approval at least 30 days prior to driving piles:

1. Mill test reports for steel materials. Mill test reports shall clearly identify heat numbers and yield strengths.

2. Safety plan for handling and installing piles close to traveled ways, railroad tracks, buildings, power lines, and other facilities. The plan shall identify and address how potential hazards will be managed to avoid property damage and injury.

3. Qualifications of the Dynamic Testing Consultant's personnel who will perform the testing, wave equation modeling, and signal matching analyses. Certification of the equipment operator who will perform the testing and the engineer who will perform the wave equation modeling and signal matching analyses shall be under the High-Strain Dynamic Pile Testing Examination and Certification process of the Pile Driving Contractors Association or the certification process of Foundation QA. The equipment operator performing the testing shall have achieved Basic or better certification and performed high-strain dynamic testing on a minimum of 10 projects within the previous two years. The engineer performing the wave equation and signal matching analyses shall have achieved Advanced or better certification, be a Registered Professional Engineer licensed to practice in the State of Nevada, and performed wave equation and signal matching analyses for a minimum of 15 projects within the last three years.

4. Completed Pile and Driving Equipment Data Form. The form will be provided by the Department. Complete and submit a separate form for each hammer proposed for driving piles. Include pile lengths and number of pieces of each length furnished for each pile type and size.

5. Summary report of the results of preconstruction wave equation modeling. The wave equation modeling shall be sufficient to assess the ability of each proposed driving system to install each pile to the required nominal capacity and the required minimum penetration depth without exceeding allowable driving stresses. The wave equation modeling shall address all combinations of proposed driving system, pile type and subsurface conditions anticipated. The report shall include appropriate drivability graphs, bearing graphs and preliminary inspector charts. Acceptability of the summary report and adequacy of the analyses will be determined by the Department.

6. Operation manual for each proposed hammer.

7. Hammer manufacturer's recommendations for cushion materials including number of layers and thicknesses for each proposed driving system.

8. Installation sequence and schedule. Include drawings indicating the order that piles will be driven. The schedule shall include each planned equipment move between substructure sites and each planned pile test.

If any of the above submittals are rejected, allow 30 days after resubmission for review and approval. No additional contract time will be provided for submittals returned for correction.

**508.01.03 Pre-activity Meeting.** Before commencement of pile driving, the Engineer will designate a time and place satisfactory to the Contractor for a pre-activity meeting. The pre-activity meeting shall be held not more than 2 weeks in advance of scheduled pile driving. The meeting shall be attended by the Contractor's superintendent and the pile driving subcontractor's superintendent. Do not commence pile driving until all issues raised at the pre-activity meeting have been satisfactorily addressed.

**508.01.04 Dynamic Testing Consultant.** Secure the services of an independent dynamic testing consultant to perform wave equation modeling, high-strain dynamic testing and signal matching analyses, and to develop pile driving criteria.

## MATERIALS

**508.02.01 General.** Material shall conform to the following Sections and Subsections:

| | |
|---|---|
| Portland Cement Concrete | Section 501 |
| Reinforcing Steel | Section 505 |
| Steel Piles | Subsection 712.03.07 |
| Steel for Pipe Piles | Subsection 712.03.08 |

Piles shall be of the type and cross section shown on the plans. Furnish and attach pile shoe as shown on the plans.

Concrete for steel pipe piles shall be Class D with the following exceptions:

| | |
|---|---|
| Minimum Compressive Strength | 28 MPa (4,000 psi) |
| Grading Limits of Combined Aggregates | 13 mm (1/2 in.) |
| Slump | 150 to 200 mm (6 to 8 in.) |

## CONSTRUCTION

**508.03.01 Furnished Pile Length.** Furnish piles in accordance with the contract documents and as required to develop the specified nominal pile capacities and satisfy minimum pile tip elevations. The lengths given in the contract documents will be based on the undamaged lengths which remain after cutoff in the completed structure. Furnish additional pile length, without added compensation, to provide for fresh heading and for such additional length as may be necessary to suit the method of operation or to facilitate high-strain dynamic testing.

**508.03.02 Equipment.** Furnish pile driving equipment that is in good operating condition and conforms to the requirements herein. Equipment will be subject to review and approval.

Use an open-end diesel or hydraulic impact hammer. Size the hammer to drive piles to their required nominal pile capacities and to the minimum tip elevations shown on the plans without overstressing the piles.

Furnish a device for monitoring the stroke of open-end diesel hammers during driving of each pile. The device shall detect each hammer blow, determine the interval of time between blows and automatically calculate and display the hammer stroke real time. Equip hydraulic hammers with a ram energy measuring system which displays hammer energy real time.

Notification of acceptance or rejection of the hammer will be made within 30 days of receipt of the pile and driving equipment data form and wave equation analysis. Approval of the hammer will be based on the following criteria determined from preconstruction wave equation analyses:

1. The required number of hammer blows at the required nominal driving resistance shall be between 16 and 98 blows per 0.25 m (20 and 120 blows per ft).

2. The driving stress in the pile shall not exceed 90% of the yield strength of the pile.

Use a helmet that fits the top of the pile and distributes hammer blows uniformly and concentrically to the pile head. The surface of the helmet in contact with the pile shall be plane and smooth and shall be aligned parallel with the base of the hammer's anvil and the top of the pile. The helmet shall be guided by the leads and shall not be free-swinging. The top of the helmet shall have a cushion pot to contain the hammer cushion material and striker plate.

Hammer cushions shall be made of durable manufactured materials that will retain uniform properties during driving. Do not use wood, wire rope, or asbestos hammer cushions. Place a striker plate on the hammer cushion to ensure uniform compression of the cushion material.

Leads shall maintain proper pile and hammer alignment during driving. Leads may be either fixed or swinging type. Fit swinging leads with a pile gate at the bottom of the leads. Adequately embed leads in the ground or constrain the pile in a structural frame such as a template to maintain alignment. Provide leads of sufficient length to make the use of a follower unnecessary. Use leads designed to facilitate proper alignment of battered piles.

The Dynamic Testing Consultant shall provide all equipment necessary for the high-strain dynamic testing, including sensors, cables, etc. The equipment shall conform to the requirements of ASTM D4945. All sensors shall be calibrated within the preceding 12 months of high-strain dynamic testing.

If pipe pile damage is suspected, furnish and operate a down-hole video camera to inspect the damage. Equip the camera with a dedicated surface unit which controls viewing direction, camera focus, and lighting intensity. Internal and external lighting shall be appropriate for conditions to yield clear images. Logging equipment shall accurately log camera depth. Single camera units shall tilt the camera 0 to 90 degrees from downward and rotate the camera sideways 0 to 360 degrees with remote control. Dual camera units shall have one camera fixed downward and a second sideways camera that rotates 0 to 360 degrees with remote control.

Only use approved pile driving equipment. Submit a revised driving equipment data form and preconstruction wave equation modeling for consideration if using equipment different than originally submitted.

Approval of pile driving equipment shall not relieve the Contractor of responsibility for pile damage or failure to achieve the required nominal capacity or minimum tip elevation.

**508.03.03 Preparation for Driving.** Do not drive piles until all equipment has been reviewed and approved and the pile driving area has been prepared as specified herein.

Complete pile cap excavation, where applicable.

Construct embankment to an elevation of at least 0.5 m (1.5 ft) above the bottom elevation of the pile cap. When an abutment area is to be surcharged, place the surcharge and wait the required period of time.

Where applicable, prebore to the depths shown on plans according to Subsection 508.03.04.

Remove the striker plate and hammer cushion from the helmet for inspection. Hammer cushion will be inspected when beginning pile driving at each structure or after each 100 hours of pile driving, whichever is less. Replace the hammer cushion when it becomes compressed in excess of 25% of its original thickness, is cracked, or begins disintegrating.

**508.03.04 Driving Piles.** Drive piles with the approved pile driving equipment to the required nominal pile capacity and minimum tip elevation shown on the plans.

Reduce the fuel setting of open-ended diesel hammers and the stroke setting of hydraulic hammers as necessary to avoid overstressing piles.

During driving, maintain proper axial alignment of the hammer with the pile.

Unless otherwise specified or approved, the order of installing individual piles in groups shall be by starting from the center of the group and proceeding progressively outward in all directions or starting at an outside row and proceeding progressively across the group.

Drive each pile to the pile tip elevation shown on the plans unless refusal occurs at a higher elevation. Refusal is defined as a driving resistance that exceeds 10 blows per inch at highest stroke that will not overstress the pile. If the pile refuses prematurely, verify that the hammer is operating properly. Each pile shall penetrate below the minimum pile tip elevation shown on the plans. When approved, preboring may be used to obtain minimum pile tip elevation. Spudding or jetting will not be permitted.

Where required, prebore holes at pile locations to the depths shown on the plans. Prebored holes shall generally be of a size smaller than the diameter or diagonal of the pile cross section that is sufficient to allow penetration of the pile to the specified depth. If subsurface obstructions, such as boulders, caliche, or rock layers are encountered, the hole diameter may be increased to the least dimension which is adequate for pile installation. Fill any void space around the pile with aggregate conforming to Subsection 706.03.03. Backfill after insertion of the pile to the bottom of the hole and after positioning and aligning the pile. Top off the prebored hole with backfill as the pile is being driven and the backfill settles.

Drive piles such that the pile heads at cutoff elevation are within 50 mm (2 in.) of plan locations for bent caps supported by piles, and within 150 mm (6 in.) of plan locations for all piles capped below final grade.

Install piles so that the axial alignment of the pile top is within 2% of the specified alignment. At shallow pile penetration, while pile alignment can be corrected, frequently stop driving to check and correct pile alignment.

Within 3 days of completing pile driving at respective pile group, provide as-built pile locations and alignments for all piles within a group if any piles within the group exceed location or alignment tolerances.

The Department will determine if each pile has adequate capacity based on the results of the high-strain dynamic testing, signal matching analysis, and refined wave equation modeling based on the results of the signal matching analysis. In general, piles driven to refusal and exhibiting no loss of driving resistance upon restrike will be assumed to have sufficient axial capacity. If the Department determines the pile capacity is insufficient at the estimated pile tip elevation shown on the plans, drive the piles deeper as directed. Splice another section onto the pile as needed. Splice as specified in Subsection 508.03.05.

Take accurate level readings referenced to a fixed datum to monitor pile heave resulting from pile driving. For each pile, take a reading immediately after each pile is driven and another reading after all piles within a 5 m (16 ft) radius are driven. Document all level readings and compute pile top elevations. Redrive all piles that have heaved more than 6 mm (1/4 in.) to their original position. Submit documentation of pile heave monitoring results, including elevation of pile tops at end of driving of each pile, elevation of pile tops after all piles within 16 feet radius are driven, and final elevation of redriven piles.

**508.03.05 Splicing.** Each pile may be built up from shorter lengths spliced together. Joined lengths shall be identical in cross section and aligned so that the axis of the pile is straight. Splicing a properly aligned section on a misaligned section will not be permitted. Weld the entire cross section of each connection in conformance with Subsection 506.03.16. If lengths are added to lengths of pile previously installed, weld it while the splice is at least 1 m (3 ft) above the ground to permit visual observation of the welded connection during driving.

**508.03.06 High-Strain Dynamic Testing.** Perform high-strain dynamic testing on piles shown or noted as test piles on the plans, or as directed. Collect test data at end of driving (EOD) and beginning of restrike (BOR) for each test pile. Restrike test piles no sooner than 24 hours after EOD.

Provide extra pile length so that 1.2 m (4 ft) of pile length remains between the pile head and the ground surface when the estimated tip elevation is reached for the placement of the testing instrumentation. If additional driving is required, splice the pile and reattach the sensors to the next pile segment prior to continuing driving.

Perform dynamic monitoring in accordance with ASTM D4945.

Warm up the hammer before restriking test piles by applying at least 20 blows to another pile. The maximum amount of penetration required during restrike shall be 75 mm (3 in), or the maximum number of hammer blows required shall be 50, whichever occurs first. The restrike may be terminated after 20 blows if pile movement is less than 6 mm (0.25 in.) during the restrike and the hammer energy output is satisfactory.

Perform signal matching analysis of at least one EOD hammer blow and at least one BOR hammer blow for each test pile. Determine based on the results of signal matching analyses the total bearing capacity at EOD and BOR for each test pile. Also determine based on the results of the signal matching analyses, the amount of end bearing, distribution of shaft resistance, and dynamic properties at EOD and BOR for each test pile. Hammer blows analyzed should be representative and suitable for analysis. Software used for signal matching shall have a published data base of at least 50 cases with correlations to static load tests.

Based on the results of the signal matching analyses, refine the wave equation model and develop appropriate driving criteria.

Within 24 hours of each high-strain dynamic test, the Dynamic Testing Consultant shall prepare and submit an individual test report summarizing the high-strain dynamic test results and results of corresponding signal matching analysis. The individual test reports shall include the calculated driving stresses, transferred energy, and estimated pile capacity at the time of testing. Variation from previous trends of high-strain dynamic test results shall also be noted. Include a discussion of hammer and driving system performance, driving stress levels, and pile integrity.

**508.03.07 Pile Acceptance.** Piles will not be accepted until all piles within a group are driven. Each pile shall be in its proper location and alignment, penetrate to minimum tip elevation, have the required nominal capacity, and be free of defects or damage.

Upon completion of driving all piles within a group, determine and document the location and alignment of each pile within the group. If the location and/or alignment tolerances specified in Subsection 508.03.04 are exceeded, the Department will evaluate the acceptance of the pile. Submit documentation of the location and alignment of each pile within the group for the evaluation.

The Department will determine if piles are mispositioned, misaligned, damaged, or defective.

Do not force mispositoned or misaligned piles back into proper position/alignment. Maintain a minimum of 100 mm (4 in.) clearance between piles and any edge of the pile cap. Increase the size of the pile cap to meet this edge distance requirement as directed at own expense.

If the Department determines that corrective measures are necessary, submit a plan for remedial action for review. Furnish all work necessary, including engineering analysis and redesign, to mitigate mispositioned, misaligned, defective, or damaged piles. Modifications to piles caused by remedial action will require calculations and working drawings stamped by a Registered Professional Engineer licensed to practice in the State of Nevada. Do not commence repair operations until remedial correction procedures or designs have been approved.

**508.03.08 Pile Cut Off.** Do not cut off piles until given approval. Cut off piles such that the pile heads at cutoff elevation are within 25 mm (1 in.) of plan elevation. Dispose of cut off lengths of piling that are not incorporated into other piles according to Subsection 107.14.

**508.03.09 Steel Pipe Piles.** Steel pipe piles consist of steel pipe driven to the required nominal pile capacity and subsequently filled with reinforcement and concrete. Reinforcing steel at the top of each pile shall conform to the details shown on the plans and the requirements of Section 505.

Do not place reinforcing steel and concrete in steel pipes until after heaved pipes have been redriven to their original position and all the steel pipes in the group have been inspected and accepted. Each steel pipe will be inspected for damage, presence of water, soil, rock or debris. Provide suitable light for inspection of the pipes. If the bottom of the pipe cannot be seen or damage is suspected, provide a down-hole video camera for closer inspection.

Remove water, soil, rock, and debris before placing reinforcing steel and concrete in each pipe. Place reinforcing steel as shown before placing concrete. Place concrete in the steel pipe continuously and so that it is dense and homogeneous. Vibrate the upper portion of the pile to a depth of 4.5 m (15 ft).

## METHOD OF MEASUREMENT

**508.04.01 Measurement.** Piles will be measured by the linear meter (linear foot), from the tip of the completed pile to the plane of pile cutoff.

Driving piles will be measured by the each for each completed pile.

High-strain dynamic tests will be measured by the each.

Splices will be measured by the each, limited to the number required to splice the pile if it becomes necessary to drive beyond estimated pile tip elevation shown on plans. Length of extensions will be determined. Splices necessary to build up piles to the estimated length shown on the plans will not be paid for.

## BASIS OF PAYMENT

**508.05.01 Payment.** The accepted quantities, measured as provided above, will be paid for at the contract price per unit of measurement for the pay items listed below that are shown in the proposal. Payment will be full compensation for the work prescribed in this section.

Test piles that become a part of the completed structure will be paid for at the contract prices for the type of piling used.

Payment will be made under:

| Pay Item | Pay Unit |
|---|---|
| Furnish Steel Piles (type) | Linear Meter (Linear Foot) |
| Furnish Steel Pipe Piles (size) | Linear Meter (Linear Foot) |
| Drive (type) Piles | Each |
| High-Strain Dynamic Test | Each |
| Splices | Each |

# SECTION 509

## DRILLED SHAFT FOUNDATIONS

DESCRIPTION

**509.01.01 General.** This work consists of constructing drilled shaft foundations.

**509.01.02 Qualifications of Drilled Shaft Contractors.** No later than 30 days prior to constructing drilled shafts, submit in writing, qualifications to perform the drilled shaft construction as specified and provide a list of 3 projects successfully completed within the previous five years using drilled shaft construction. The list of projects shall contain names and current phone numbers of owner's representatives who can verify participation on those projects.

On-site supervisors shall have a minimum of 3 years experience in supervising construction of drilled shafts of both diameter and length, and similar geotechnical conditions, to those shown on the plans. Drill rig operators shall have a minimum of 1 year drilling experience in construction of drilled shafts of both diameter and length, and similar geotechnical conditions, to those shown on the plans.

**509.01.03 Submittals.** Submit an installation plan for review a minimum of 15 days prior to constructing drilled shafts. This plan shall provide information on the following:

1. Name and experience record of drilled shaft superintendent who will be in charge of drilled shaft operations.

2. List of proposed equipment to be used, including cranes, drills, soil augers, rock augers, coring buckets, bailing buckets, chipping and grooving tools, final cleanout equipment, de-sanding equipment, slurry pumps, slurry tanks, slurry sampling and testing equipment, core sampling equipment, tremies, concrete pumps, and casing.

3. Details of overall construction operation sequence and sequence of shaft construction in bents or groups.

4. Details of shaft excavation methods, procedures, and sequence. Describe proposed drilling methods, cleanout methods, methods ensuring shaft stability, disposal plan for excavated material, and treatment of hazardous waste material encountered.

5. Details of the slurry mix design, including suitability for the subsurface conditions at the site, mixing and storage methods, maintenance methods, slurry disposal procedures, provisions for controlling slurry quality including test types, sampling techniques, test methods, frequency of tests, specified property requirements to ensure the slurry meets its intended functions.

6. Details of reinforcement placement, including support and centralization methods.

7. Details of concrete placement, including concrete delivery schedule, proposed operational procedures for tremie and pumping methods, and methods for removal and disposal of contaminated concrete.

8. Details of casing, including methods of installation, advancement, and removal.

9. Provide a signed statement from the drilling contractor that inspection has been made of both the project site and all the subsurface information made available, including any soil or rock samples referenced in the contract documents.

The drilled shaft installation plan will be evaluated for conformance with the contract requirements. Notification will be given within 14 days after receipt of the installation plan of any additional information required and/or changes necessary. Approval of the plan shall not operate to relieve the responsibility under the contract for the successful completion of the work, nor shall approval of the plan operate as a warranty that the plan will succeed or will be the most economical or efficient method of completing the work. Adhere to the approved plan for the remainder of the contract. Subject to acceptable field performance, or if changes in equipment or construction methods occur, submit a revised plan for review and approval.

**509.01.04 Pre-Activity Meeting.** A pre-activity meeting will be scheduled prior to commencement of drilled shaft construction. As a minimum, the Contractor, the drilling sub-contractor, and the Engineer shall attend the meeting.

## MATERIALS

**509.02.01 General.** Material shall conform to the following Sections:

| | |
|---|---|
| Portland Cement Concrete | Section 501 |
| Reinforcing Steel | Section 505 |
| Concrete Curing Materials and Admixtures | Section 702 |

Concrete for drilled shafts for bridge structures shall be Class S where shown on the plans. Concrete for all other drilled shafts shall be Class S or Class D.

Concrete shall conform to Section 501 with the following modifications:

| | |
|---|---|
| Minimum Compressive Strength for Class D | 28 MPa (4,000 psi) |
| Grading Limits of Combined Aggregates * | 13 mm (1/2 in.) |
| Slump Range ** | 175 to 225 mm (7 to 9 in.) |

* See Section 706 for Grading Limits of Combined Aggregates. If approved, 10 mm (3/8 in.) may be used in lieu of 13 mm (1/2 in.). For drilled shafts required as specified in Section 623, the grading requirements shall be as specified in Table I of Subsection 501.02.05.

** See Section 501 for Slump Range requirements for Class S concrete. All classes of concrete shall have a minimum slump of 175 mm (7 in.) at 3 hours. For 3 hour, or extended time slump tests, store a sufficient quantity of concrete in sealed five gallon buckets at room temperature.

## CONSTRUCTION

**509.03.01 Construction Sequence.** Complete excavation to top of shaft elevation without pauses or stops, except for casing splicing or removal of obstructions, before shaft construction begins, unless otherwise noted or approved. Recompact and regrade any disturbance to the footing or pile cap area prior to the footing or pile cap concrete placement.

If the shaft excavation is not completed at the end of the shift or series of continuous shifts, the shaft excavation operation may be stopped, provided the shaft is protected against sidewall instability. Do not leave shaft excavations unprotected overnight. Protect shaft excavations against sidewall instability by casing full depth. If approved in writing, slurry may be used to protect a shaft during a drilling stoppage or overnight shutdown. Casing will not be required in stable rock formations during shaft excavation stoppages.

When drilled shafts are to be installed in conjunction with embankment placement, construct drilled shafts after the placement of embankment, unless otherwise noted or approved. In the case of drilled shafts constructed prior to the completion of the embankment, place pile caps or footings after the embankment has been placed as near to final grade as possible. Leave only the necessary work room for construction of the caps or footings.

**509.03.02 Construction Methods.** Perform excavations required for shafts, through whatever materials are encountered to the dimensions and elevations shown in the plans or as required. Use construction methods suitable for the intended purpose and materials encountered. Blasting will not be permitted unless noted on the plans or authorized in writing.

(a) Dry Construction Method. The dry construction method consists of drilling the shaft excavation, removing accumulated water and loose material from the excavation, placement of the reinforcing cage, and placement of concrete in a relatively dry excavation.

Use the dry construction method when:

1. There is less than 75 mm (3 in.) of standing water in the bottom of the shaft excavation, and less than 0.3 m (1 ft) of ground water accumulates above the base of the excavation over a one hour period when no pumping is permitted.

2. The sides and bottom of the excavation remain stable, with no detrimental caving, sloughing, or swelling occurring prior to placement of reinforcement.

3. The sides and bottom of the shaft can be visually inspected prior to placement of reinforcing steel and/or concrete.

If conditions are such that the above requirements are not satisfied, use wet construction and/or casing construction methods.

(b) Wet Construction Method. The wet construction method consists of using drilling slurry to maintain the stability of the borehole perimeter while advancing the excavation to the specified bottom elevation, placement of the reinforcing cage, and concreting the shaft. Where drilled shafts are located in open water areas, extend exterior casings from above the water elevation into the ground to protect the shaft concrete from water action during placement and curing. Install exterior casings in a manner that will produce a positive seal at the bottom of the casing so that no piping of water or other materials occurs into or from the shaft excavation. Use the wet construction method at sites where a dry excavation cannot be maintained for placement of the shaft concrete.

(c) Casing Construction Method. The casing construction method consists of placing a casing into a predrilled hole or advancing a casing through the ground by twisting, driving, or vibration before being cleaned out. Use the casing method when shown on the plans or at sites where the dry or wet construction methods are inadequate to prevent caving or excessive deformation of the hole. Use permanent casing only at locations shown on the plans or when approved.

**509.03.03 Equipment.** Use excavation and drilling equipment having adequate capacity, including power, torque, and down thrust to excavate a shaft of the required diameter and to a depth 20% greater than required. Excavation and overreaming tools shall be of adequate design, size, and strength to perform the work.

When the material encountered cannot be drilled using conventional earth augers with soil or rock teeth, drill buckets, grooving tools, and/or overreaming tools, provide special excavation equipment such as rock core barrels, rock tools, air tools, blasting materials, and other equipment as necessary to construct the shaft excavation to the size and depth required.

**509.03.04 Excavations.** Excavate shafts at locations and to the top of shaft elevations, estimated bottom of shaft elevations, shaft geometry and dimensions shown in the contract documents. Extend drilled shaft tip (base) elevations as directed, when the material encountered during excavation is determined to be unsuitable.

Overream sidewalls of shafts when the sidewalls have either softened due to excavation methods, swelled due to delays in concreting, or degraded due to slurry cake buildup. Overream to a minimum thickness of 13 mm (1/2 in.) and a maximum thickness of 75 mm (3 in.). Accomplish overreaming with a grooving tool, overreaming bucket or other approved equipment. The thickness and limits of sidewall overreaming will be determined.

Utilize suitable excavated material for backfilling or in embankments. Dispose of unsuitable or surplus material according to Subsection 107.14.

**509.03.05 Excavation Inspection.** Provide all equipment for checking the dimensions and alignment of each shaft excavation. Provide lights, mirrors, weighted tape, weighted probe, personnel, and all assistance required to perform inspection of the drilled shaft construction. Use the equipment to obtain all measurements as directed.

Measure final shaft depth with a suitable weighted tape or other approved methods after final cleaning. The maximum depth of sediment or any debris at any place on the base of the shaft shall not exceed 25 mm (1 in.). For dry shafts, remove all cuttings that may have been smeared on the sidewalls during the insertion and removal of drilling tools. In addition, for dry excavations, the maximum depth of water shall not exceed 75 mm (3 in.) prior to concrete placement. Shaft inspection will be made after final cleaning by visual inspection for dry shafts or other methods deemed appropriate for wet shafts, such as sounding with a weighted tape or probe. Do not proceed with shaft construction until the shaft has been inspected and accepted.

**509.03.06 Obstructions.** Give notification immediately when obstructions are encountered. Remove surface and subsurface obstructions at drilled shaft locations. Such obstructions may include, but are not limited to, man-made materials such as old foundations or construction debris and natural materials such as cobbles, boulders, or cemented soils. Employ special procedures and tools when the shaft cannot be advanced using augers, drilling buckets, or overreaming tools. Such special procedures and tools may include, but are not limited to, chisels, boulder breakers, core barrels, air tools, hand excavation, temporary casing, and increasing the shaft diameter. Do not blast to remove obstructions unless approved in writing.

Retrieve and dispose of all excavating equipment and tools lost during shaft excavation.

**509.03.07 Exploration (Shaft Excavation).** Obtain soil samples or rock cores to determine the character of the material directly below the completed shaft excavation where shown on the plans or as directed.

Extract soil samples with a split spoon sampler or undisturbed sample tube, using the designated soil sampling technique.

Cut rock cores with an approved double or triple tube core barrel to a minimum of 3 m (10 ft) below the shaft excavation either before the excavation is made or at the time the shaft excavation is approximately complete. Extend the depth of coring to 6 m (20 ft) below the bottom of the shaft when directed. Measure, visually identify, and record rock core samples in an appropriate field log. Also, describe and record standard penetration test blow counts and samples in the log.

Place samples in suitable containers, identified by shaft location, elevation, and contract number and deliver with the field log to the Engineer. When samples are obtained after completion of the shaft excavation, deliver the field log and samples immediately upon completion of sampling.

The material will be inspected and a decision will be made on the suitability of the bearing stratum within 2 days. When samples are obtained prior to excavating the shaft, deliver the samples and field log within 24 hours of sampling. Inspection of the samples/cores will be made and the final depth of required excavation will be determined within 3 days. Furnish 2 typed copies of the final log at the time the shaft excavation is completed and accepted.

**509.03.08 Casings.** Use steel casings which are smooth, clean, watertight, and of sufficient strength to withstand both handling and driving stresses and the pressure of both concrete and the surrounding earth materials. The outside diameter of the casing and the diameter of any excavation made below the casing shall not be less than the specified diameter of the shaft, or more than 150 mm (6 in.) greater than the specified diameter of the shaft at no cost to the Department. Remove all casings, except permanent casings, from shaft excavations. Any length of permanent casing installed below the shaft cutoff elevation shall remain in place.

Extract casing prior to initial set to allow the concrete cast against the surrounding soil to develop the designed skin friction. Leave casing not extracted within the allotted time in the excavation. If casing is not extracted from the excavation, the shaft will be reevaluated to determine if any loss of capacity has occurred. Any loss of capacity may be grounds for the shaft to be considered defective. If any shaft is determined to be defective, submit a plan for remedial action for approval.

(a) Temporary Casing. Provide temporary casing in sufficient quantities to meet the needs of the anticipated shaft condition. All subsurface casing shall be considered temporary unless specifically shown as permanent casing in the contract documents. Remove temporary casing before completion of concreting the shaft. Telescoping, predrilling with slurry, or overreaming to beyond the outside diameter of the casing may be required during installation.

If electing to remove a casing and substitute a longer or larger-diameter casing through caving soils, the excavation shall be either stabilized with slurry or backfilled before the new casing is installed. Other methods may be used to control the stability of the excavation and protect the integrity of the foundation materials when approved.

Extract casing at a uniform rate with the pull in line with the shaft axis. As the casing is withdrawn, maintain an adequate level of concrete within the casing so that fluid trapped behind the casing is displaced upward and discharged at the ground surface without contaminating or displacing the shaft concrete.

Temporary casings which become bound or fouled during shaft construction and cannot be practically removed shall constitute a defect in the shaft. Submit a plan for approval to correct such defective shafts. Such improvement may consist of, but is not limited to, removing the shaft concrete and extending the shaft deeper to compensate for loss of frictional capacity in the cased zone, providing straddle shafts to compensate for capacity loss, or providing a replacement shaft. Any foundation redesign must be performed by a Registered Professional Engineer, licensed to practice in the State of Nevada.

(b) Permanent Casing. Use permanent casing when shown in the contract documents. Provide continuous full length casing between the top and bottom elevations of the shaft. Splice permanent casing according to Article 6.13.3 of the AASHTO LRFD Bridge Design Specifications. Cut off permanent casing, after installation is complete, at the prescribed elevation, and complete the shaft construction by installing necessary reinforcing steel and concrete in the casing.

**509.03.09 Slurry.** During construction, maintain the level of the slurry at a height sufficient to prevent caving of the hole. In the event of a sudden significant loss of slurry in the hole, cease construction of the foundation until either a method to stop slurry loss or an alternate construction procedure has been approved.

Provide a manufacturer's representative, slurry supplier's representative, or third-party technical representative to oversee slurry operations and perform slurry control tests.

Perform tests during the shaft excavation to verify specification requirements and ensure material consistency. Conduct a minimum of 4 sets of tests during the first 8 hours of slurry use. When the results show consistency, the testing frequency may be decreased to 1 set every 4 hours of slurry use. Sample and test slurry immediately prior to placing concrete.

Ensure that a heavily contaminated slurry suspension, which could impair the free flow of concrete, has not accumulated in the bottom of the shaft. Prior to placing concrete in any shaft excavation, take slurry samples using an approved sampling tool. Extract 2 slurry samples, 1 from within 0.6 m (2 ft) of the base of the shaft and 1 at mid-height in the shaft, until the samples produce acceptable test results.

When slurry samples are found to be unacceptable, take whatever action is necessary to bring the slurry within specification requirements. Do not place concrete until the slurry in the hole is re-sampled and test results produce acceptable values.

Furnish signed test reports of all tests required upon completion of each drilled shaft.

(a) Mineral Slurry. Mineral slurry shall have both a mineral grain size that will remain in suspension and sufficient viscosity and gel characteristics to transport excavated material to a suitable screening system. The percentage and specific gravity of the material used to make the mineral suspension shall be sufficient to maintain the stability of the excavation and to allow proper concrete placement.

Premix mineral slurry thoroughly with clean water and allow adequate time (as prescribed by the mineral slurry manufacturer) for hydration prior to introduction into the shaft excavation. Provide slurry tanks of adequate capacity for slurry circulation, storage, and treatment. Use of slurry pits will not be allowed. Provide desanding equipment to control slurry sand content to within specification any point in the borehole at the time slurry is introduced, including situations in which temporary casing is used. Take steps necessary to prevent the slurry from “setting up” in the shaft. Such methods may include agitation, circulation, and adjusting the properties of the slurry. Dispose of slurry material according to Subsection 107.14.

Mineral slurry shall be at least 4 °C (40 °F) when tested and shall conform to the following requirements:

| Property | Test Method | Requirement |
|---|---|---|
| Density, lb/ft$^3$ | Mud Weight, API 13B-1, Section 1 | 64 to 72 |
| Viscosity, sec/qt | Marsh Funnel and Cup, API 13B-1, Section 2.2 | 28 to 50 |
| pH | Glass Electrode, pH Meter, or pH Paper | 8 to 11 |
| Sand Content, % by volume | Sand, API 13B-1, Section 5 | 4.0 Max. |

(b) Synthetic Slurry. Mix synthetic slurry in accordance with the manufacturer’s recommendations. Follow the manufacturer’s recommendations for disposal of synthetic slurry and dispose of according to Subsection 107.14.

Synthetic slurry shall be at least 4 °C (40 °F) when tested and shall conform to the following requirements:

| Property | Test Method | Requirement |
|---|---|---|
| Density, lb/ft$^3$ | Mud Weight, API 13B-1, Section 1 | 64 Max. |
| Viscosity, sec/qt | Marsh Funnel and Cup, API 13B-1, Section 2.2 | Manufacturer’s Recommendation |
| pH | Glass Electrode, pH Meter, or pH Paper | 8 to 11.5 |
| Sand Content, % by volume | Sand, API 13B-1, Section 5 | 1.0 Max. |

(c) Water Slurry. Do not use water only as a drilling fluid, unless approved in writing. Consider naturally occurring water as drilling fluid. When water only is approved for use, the fluid shall conform to the following requirements:

| Property | Test Method | Requirement |
|---|---|---|
| Density, lb/ft$^3$ | Mud Weight, API 13B-1, Section 1 | 64 Max. |
| Sand Content, % by volume | Sand, API 13B-1, Section 5 | 1.0 Max. |

**509.03.10 Construction Tolerances.** Construct shaft foundations to plan dimensions within the tolerances specified herein.

The diameter of the shaft shall not be less than the specified diameter and shall not be more than 150 mm (6 in.) greater than the specified diameter.

Construct the center of the drilled shaft within 75 mm (3 in.) of plan position in the horizontal plane at the plan elevation for the top of the shaft.

The vertical alignment of a vertical shaft excavation shall not vary from the plan alignment by more than 20 mm per m (1/4 in. per ft) of depth.

After concrete placement, the top of the reinforcing steel cage shall be no more than 150 mm (6 in.) above and no more than 75 mm (3 in.) below plan position. Provide minimum cover of 150 mm (6 in.) for all reinforcing steel for shafts 1.5 m (5 ft) or larger in diameter, and a minimum cover of 100 mm (4 in.) for all reinforcing steel for shafts less than 1.5 m (5 ft) in diameter.

A casing larger in diameter than shown in the plans may be used only when approved.

The top elevation of the shaft shall not be less than 75 mm (3 in.) below the plan top-of-shaft elevation and shall not be more than 25 mm (1 in.) above the plan top-of-shaft elevation.

Employ excavation equipment and methods so that the completed shaft excavation will have a level planar bottom. The cutting edges of excavation equipment shall be normal to the vertical axis of the equipment within a tolerance of ± 30 mm per m (0.375 in. per ft) of diameter.

Drilled shaft excavations and completed shafts not constructed within the required tolerances are unacceptable. Correct all unacceptable shaft excavations and completed shafts by approved methods. Engineering analysis and/or drilled shaft redesign to correct out-of-tolerance drilled shafts shall be performed by a Registered Professional Engineer, licensed to practice in the State of Nevada. Submit proposed corrective measures for approval.

**509.03.11 Reinforcing Steel Cage Construction and Placement.** Reinforcing steel shall conform to the details shown on the plans and the requirements of Section 505. Double tie, with double wires, every other intersecting vertical and spiral or hoop members of the reinforcing cage in each direction. Assemble and place the reinforcing steel cage, consisting of longitudinal bars, spiral or hoop reinforcement, cage stiffeners, spacers, centralizers, integrity testing tubes, and other necessary appurtenances, as a unit within 30 minutes after the shaft excavation is inspected and accepted. Remove internal stiffeners as the cage is placed in the shaft so as not to interfere with the placement of concrete. Support the reinforcing steel cage from the top at all times until completion of concrete placement.

Tie and support the reinforcing steel in the shaft so that the reinforcing steel will remain within allowable tolerances given in Subsection 509.03.10. Use non corrosive rollers of sufficient strength and durability to withstand construction stresses near the bottom and at intervals not exceeding 3 m (10 ft) up the shaft to ensure concentric spacing for the entire cage length in the excavation. Use rollers of adequate dimension to ensure a minimum of 150 mm (6 in.) annular space between the outside of the reinforcing cage and the side of the excavation for shafts 1.5 m (5 ft) or larger in diameter. Provide rollers of adequate dimension to ensure a minimum of 100 mm (4 in.) annular space between the outside of the reinforcing cage and side of the excavation for shafts less than 1.5 m (5 ft) in diameter. Provide approved cylindrical feet (bottom supports) to ensure that the bottom of the cage is maintained the proper distance above the base.

Verify the elevation of the top of the steel cage before and during the concrete placement. If the upward displacement of the rebar cage exceeds 50 mm (2 in.) or if the downward displacement exceeds 150 mm per 6.1 m (6 in. per 20 ft) of shaft length, the drilled shaft will be considered defective. Submit correction procedure for approval. Cease shaft construction until the method of supporting the reinforcing steel cage is modified to produce acceptable results.

**509.03.12 Concrete Placement.** Place concrete using a concrete pump by means of extension pipe or a tremie pipe with a hopper attached to the top. Do not use pipes having aluminum parts that will come into contact with the concrete. The inside and outside surfaces of the pipe shall be clean and smooth to permit both flow of concrete and unimpeded withdrawal during concreting. Use watertight pipes consisting of solid steel or jointed tube of sufficient length, weight, and diameter to discharge concrete at the shaft base elevation. The wall thickness of the pipe shall be adequate to prevent crimping or sharp bends, which restrict concrete placement. Concrete pump extension pipes shall have a minimum 125 mm (5 in.) inside diameter. Tremie pipes shall have an inside diameter at least six times the maximum size of aggregate used in the concrete mix but shall not be less than 250 mm (10 in.).

A "Concrete Brake," which allows a head of concrete to be built up in the delivery pipe and reduces the air pumped into shaft, is required at the top of the pipe. The brake shall consist of a bladder valve or French horn. Ensure that concrete completely fills the pipe without air gaps.

Place concrete within 1 hour after the shaft excavation is inspected and accepted. If this 1 hour limit is exceeded, remove the reinforcing cage to allow for reinspection as directed.

Do not exceed 3 hours from the beginning of concrete placement in the shaft to the completion of concrete placement. A longer placement time may be approved, when requested, provided that the supplied concrete mix maintain a slump of 175 mm (7 in.) or greater over the longer placement time. The slump test will be performed according to Subsection 509.02.01.

Concrete shall be placed for each shaft with the flow of concrete directed down the center of the shaft.

Install a foam or inflatable 'pig' in the top of the pipe. The 'pig' shall form a tight seal within the pipe. Fill the pipe completely and force the 'pig' to the bottom of the drilled shaft, thus forcing the water out of the pipe, providing separation between the concrete and the ground water. Lift the full pipe one pipe diameter to start the flow and seal the discharge end of the pipe in concrete. Do not raise the pipe until it is immersed at least 1.5 m (5 ft) in concrete. Keep the discharge end of the pipe in a minimum of 1.5 m (5 ft) of concrete at all times after starting the flow of concrete. Maintain a continuous flow of concrete and keep the level of the concrete in the pipe above the level of slurry or water in the shaft at all times to prevent water or slurry intrusion into the shaft concrete.

Concrete placement shall be continuous from the bottom elevation to the top of the shaft, and shall continue after the shaft excavation is filled until quality concrete is evident at the top of the shaft.

Do not begin underwater or under-slurry concrete placement until the pipe is placed to the shaft base elevation. Keep the concrete completely separated from the water or slurry prior to the time it is discharged.

Pump debris, mud, water, and contaminated concrete forced up during concrete placement directly into a truck for disposal unless alternate methods are approved.

When Class D concrete is specified and casing is utilized, vibrate the concrete during withdrawal of the last 4.5 m (15 ft) of the casing. Do not vibrate Class S concrete. Keep the vibrator below the bottom of the casing during removal. Where steel casings have been used to support the excavation walls, withdraw the casing as the concrete is being placed within the limits previously specified in Subsection 509.03.08. Remove the steel liner in a manner so that the lower edge of the steel liner always remains a minimum of 1.5 m (5 ft) below the surface of the concrete being placed to prevent water or soil from entering the shaft excavation from below the bottom of the casing. Submit for approval, appropriate procedures and methods of withdrawal of steel liners to ensure that the concrete is not being lifted or contaminated as the steel liner is being withdrawn.

Before placing any fresh concrete at a cold joint or construction joint, remove all scum, laitance, loose gravel, and sediment from the surface of the concrete.

Cure the top surface of the shaft as prescribed in Subsection 501.03.08.

If at any time during the concrete pour the pipe orifice is removed from the fluid concrete column and/or discharges concrete above the rising concrete level, the shaft, as determined by the Engineer, will be considered defective. All costs of testing, mitigation, and/or replacement of defective shafts shall be at no cost to the Department.

**509.03.13 Inspection Report.** Provide any assistance that may be required for the Engineer to prepare and submit daily reports for the complete drilled shaft construction program. The reports will include: logging all excavated soils, concrete quantities and rate of delivery, description of tools and drill rigs used and any changes necessitated by changing ground conditions, recording actual elevations at top and bottom of each drilled shaft, elevation of rock (if any), plumbness of casing and rebar cages, seepage of water, elevation of top and bottom of any casing left in place, any unusual conditions, and any other pertinent information deemed necessary.

**509.03.14 Integrity Testing.** All completed drilled shafts may be tested with a nondestructive testing (NDT) method called Crosshole Sonic Logging (CSL) or other approved method. Testing will be performed by an approved independent testing organization under a separate contract with the Department.

For the purposes of the above tests, install integrity testing tubes to permit access for the test probes. The tubes shall have an inside diameter of 50 mm (2 in.) ± 6 mm (1/4 in.) and shall be Grade B Schedule 40 steel pipe conforming to ASTM A53. The tubes shall have a round, regular inside diameter free of defects or obstructions, including obstructions at any pipe joints, in order to permit the free, unobstructed passage of 35 mm (1.375 in.) diameter test probes.

The tubes shall be watertight, free from corrosion with clean internal and external faces to insure good bond between the concrete and the tubes. Fit the tubes with a watertight cap on the bottom and a removable watertight cap on the top.

Securely attach the tubes at equal spacings along the interior circumference of the reinforcement cage of each drilled shaft or as shown in the plans. Install tubes at least 0.9 m (3 ft) above the shaft top to within 25 mm (1 in.) of the actual drilled shaft tip elevation. Take care to prevent damaging the tubes during reinforcement cage installation operations in the drilled shaft excavation. Fill the tubes with potable water, verify the tubes are water tight, and cap the tube tops prior to concrete placement. Check within 6 to 12 hours to verify water remains above the level of the poured concrete and top off water as needed. Refer to Section 722 for water requirements.

Testing will be performed after concrete has cured between 4 days and 8 days. Additional curing time prior to testing may be required if the shaft concrete contains admixtures, such as set retarding admixture or water reducing admixture. Results of the testing will be given within 7 days after testing is completed.

If the inspection equipment cannot pass through the full length of the inspection tube or a tube is determined to be defective and unable to be used for testing purposes, core a 50 mm (2 in.) diameter hole through the concrete for the full length of the pile (or as directed for testing) to replace the defective tube at own expense. Unless otherwise directed, place the inspection core holes approximately 150 mm (6 in.) inside the reinforcing cage, as near as possible to the impassable access tube, without damaging the reinforcing cage.

If any shaft is determined to be unacceptable, submit calculations on the structural condition of the shaft, as well as a plan for remedial action for approval. Furnish satisfactory materials and work necessary, including engineering analysis and redesign, to mitigate shaft defects at no cost to the Department. Any modifications to the dimensions of the drilled shafts shown on the contract plans caused by remedial action will require calculations and working drawings stamped by a Registered Professional Engineer licensed to practice in the State of Nevada. Drill a core hole in any shaft of questionable quality (as determined from the test results or by observation to explore the shaft condition. Use a coring method that provides complete core recovery and minimizes abrasion and erosion of the core (i.e., double or triple core barrels). If a defect is confirmed, the Contractor shall pay for all coring costs, regardless of whether mitigation is performed, or if the shaft is accepted. Provide downhole video upon request, to ascertain the condition of the shaft interior, and any defects present. If no defect is encountered, the State will pay for all coring costs, and compensation for the delay will be granted by an appropriate time extension and payment. All delays between the time a shaft is rejected and shaft remediation resulting in shaft acceptance are at the Contractor's expense.

After completion of the testing and acceptance of the shaft foundation, cut off the testing tubes flush with the top of the shaft foundation. Fill testing tubes and core holes with grout consisting of 0.45 maximum water/cement ratio. Provide mixing and pumping equipment that can fill the tubes and core holes from the bottom up.

**509.03.15 Scheduling and Restrictions.** After the first drilled shaft has been successfully constructed, make no significant change in construction methods, equipment, or materials to be used in the construction of such shafts unless approved.

The first drilled shaft in each pile group at piers and abutments must be approved before proceeding with concrete placement in remaining shafts.

Do not place reinforcing steel or concrete above designated shaft construction joints until the testing of the lower portion of the shaft has been completed, test results obtained, and the lower portion of the shaft has been approved.

For a period of at least 24 hours after drilled shaft concrete has been placed, do not excavate adjacent shafts, do not place excessive wheel loads, and do not allow vibration to occur or be felt at any point within 3 m (10 ft) or 3 times the shaft diameter, whichever is greater, from the periphery of the drilled shaft.

Failure to satisfactorily perform the procedures described above may result in shut down of the construction operation and/or rejection of the drilled shaft. If the integrity of the drilled shaft is in question, employ core drilling, CSL, or other approved methods as directed. Backfill core-drilled holes with grout. Submit a remediation plan and perform remedial measures as approved or as directed. No compensation will be made for costs, losses or damages due to remedial work or any testing required on drilled shafts due to not meeting the requirements.

Do not cast pile caps or the footings of pier columns on the drilled shafts until at least 7 days have elapsed, or 80% of the compressive strength is obtained.

**509.03.16 Load Testing.** When the contract documents include load testing of shafts, complete all load tests before construction of any production drilled shafts. Allow 5 working days after the last load test for the analysis of the load test data and final determination of base elevations, by the Engineer, before receiving authorization to proceed with the construction of production shafts. The number and locations of load tests will be as shown on the plans or as designated.

Provide notification 10 days before conducting load tests.

(a) Static Load Testing. Do not begin static load testing until the concrete has attained a compressive strength of 23.4 MPa (3,400 psi) as determined from cylinder breaks. Drilled shafts shall be load tested in the order as directed. Perform static load tests in compliance with ASTM D1143 for axial load testing, and ASTM D3966 for lateral load testing. Supply all equipment necessary to conduct the static test, including equipment to measure loads and deflections as shown on the plans. Design the loading frame apparatus to safely accommodate the maximum load to be applied. Unless specified otherwise, load the test shafts to a maximum test load corresponding to failure. Failure is defined as a deflection of the shaft head equal to 5% of the shaft diameter.

Load cells will be required to measure applied load during the drilled shaft load tests. Provide load cells of adequate size to measure the maximum load applied to the shaft and equip with an adequate readout device. Before load testing begins, furnish a certificate of calibration for the load cell from an NDOT approved testing laboratory. The calibration shall have been completed for all ranges of proposed loading within the 6 months preceding the load tests. The certified accuracy of the load cell shall be within one percent of the true load.

After testing is completed, cut off the non production test shafts (and any reaction shafts) at an elevation 0.6 m (2 ft) below the finished ground surface. Remove and dispose the portion of the shafts that were cut off.

(b) Dynamic Load Testing. Testing requirements will be specified in the Special Provisions.

(c) Load Cell Testing. Testing requirements will be specified in the Special Provisions.

## METHOD OF MEASUREMENT

**509.04.01 Measurement.** Drilled shafts will be measured by the linear meter (linear foot), measured from the top of shaft elevation to the bottom of shaft elevation.

Exploration (Shaft Excavation) will be measured by the linear meter (linear foot), measured for the length explored.

Static, dynamic, and load cell tests will be measured by the each.

If Portland cement concrete is placed and is shown by tests to be below the specified 28 day compressive strength, liquidated damages will be assessed as specified in Subsection 502.04.01. If allowed to remain in place, the entire quantity of concrete in each substandard shaft will be assessed liquidated damages. The unit bid price used to calculate liquidated damages will be \$600.00/$m^3$ (\$460.00/$yd^3$).

## BASIS OF PAYMENT

**509.05.01 Payment.** The accepted quantities, measured as provided above, will be paid for at the contract price per unit of measurement for the pay items listed below that are shown in the proposal. Payment will be full compensation for the work prescribed in this Section.

Payment will be made under:

| Pay Item | Pay Unit |
|---|---|
| Drilled Shaft Foundation (size) | Linear Meter (Linear Foot) |
| Exploration (Shaft Excavation) | Linear Meter (Linear Foot) |
| Static Load Test | Each |
| Dynamic Load Test | Each |
| Load Cell Test | Each |

# SECTION 600

## TRENCH DRAINS

DESCRIPTION

**600.01.01 General.** This work consists of constructing trench drains.

MATERIALS

**600.02.01 General.** Material shall conform to the following Sections:

Portland Cement Concrete ..... Section 501
Reinforcing Steel ..... Section 505

Trench drains consist of prefabricated drain sections along with concrete backfill. Use prefabricated portions of trench drains listed in the QPL and that meet the minimum requirements specified in the contract documents.

Backfill shall be Class A or Class AA concrete.

Trench drains shall be rated for installation in a highway environment where snowplows and high-speed highway traffic will be present.

Trench drain channels shall have minimum slope of 0.5%, unless specified otherwise. Dimensions and depths specified are the minimum acceptable. Increased depths shall maintain or increase trench slope and provide positive drainage to the connecting inlet. The trench width (W) specified shall be the minimum internal width of the trench and not the grate width. Changes to the specified dimensions, or minor differences between nominal and actual dimensions will only be allowed with written approval.

Frames and grates shall be capable of withstanding H-20 loading in accordance with AASHTO M306.

Grates shall be bicycle safe and removable. Grates shall have a minimum open area of 50%. Removable grates shall be held in place by locking devices that are tamper resistant and provide a minimum repetitive pullout resistance of 223 kg per linear meter (150 pounds per linear foot) of inlet grate after completion of 1000 hours of salt spray testing in accordance with ASTM B117.

Grates shall fit into frames without rocking. Frames shall be secured to the surrounding concrete backfill with steel anchoring rods a minimum of 6 mm (1/4 in.) in diameter and a minimum of 125 mm (5 in.) in length. Alternatively, other methods of securing the frame to the concrete backfill or trench drain will be acceptable provided that a minimum pullout resistance of 446 kg per linear meter (300 pounds per linear foot) of length of trench drain frame is assured.

Trench drain systems selected shall be capable of accommodating any horizontal or vertical curves or deflections of the roadway segment they are to be constructed in.

CONSTRUCTION

**600.03.01 General.** Install trench drains according to the plans, manufacturer's recommendations, and as specified.

Sawcut existing plantmix or concrete surfaces to the required dimensions. Excavate in accordance with Section 206 to the lines and grades as shown on the plans and as directed.

Grade and compact the trench bottom to provide a firm and uniform bearing throughout the entire length of the trench drain.

Provide the necessary facilities and equipment for lowering and properly placing the sections of trench drain in to the trench.

Lay and join the trench drain in accordance with the manufacturer's recommendations and connect to the proposed drop inlets.

Position the drain sections in the excavated trench so that, when finished, the surrounding concrete backfill will be a minimum of 3 mm (1/8 in.) and a maximum of 5 mm (3/16 in.) above the level of the inlet frame. In no case shall the frame or grate of the trench extend above the level of the surrounding concrete backfill.

Maintain full and unobstructed cross sectional flow area throughout the entire length of the trench drain installation. Outlet plates, end caps, adapters, pipe outlets, or other reducers and restrictions in flow area will not be permitted at the trench drain outlet connection.

Place the concrete backfill as shown on the plans, but in no case shall the thickness of concrete backfill, when measured normal to the walls or bottom of the trench drain, be less than 150 mm (6 in.).

Place the concrete backfill in the trench against undisturbed material at the sides and bottom of the trench and in a manner that will prevent floating or shifting of the trench drain and voids in, or segregation of, the concrete. Immediately remove foreign material which has fallen into the trench prior to, or during, placement of the concrete. Where necessary, forming or earth plugs shall be constructed and compacted at the ends of the planned concrete backfill to contain the concrete within the trench.

Finish the concrete backfill flush with adjacent surfacing unless specified otherwise.

Where trench drains are to be installed and connected to existing facilities, remove the required portion of the existing structure to accommodate the installation. Perform the removal with equipment that will not damage the existing structure. Dispose of removed materials according to Subsection 107.14. Provide a watertight mortared joint at the connection. Remove excess mortar and finish surfaces smooth.

## METHOD OF MEASUREMENT

**600.04.01 Measurement.** Trench drains will be measured by the linear meter (linear foot) for the length shown on the plans. If the incremental segment length of the trench drain selected does not match the specified length, one additional segment shall be constructed in order to provide the minimum length specified. The additional length of trench drain placed in excess of the length shown on the plans will not be measured for payment.

Excavation for trench drains will be measured and paid for according to Section 206.

## BASIS OF PAYMENT

**600.05.01 Payment.** The accepted quantities, measured as provided above, will be paid for at the contract price per unit of measurement for the pay items listed below that are shown in the proposal. Payment will be full compensation for the work prescribed in this Section.

Payment will be made under:

| Pay Item | Pay Unit |
|---|---|
| Trench Drain | Linear Meter (Linear Foot) |

# SECTION 601

## PIPE CULVERTS — GENERAL

### DESCRIPTION

**601.01.01 General.** These specifications include general requirements that are applicable to all types of culvert pipes except structural plate pipe, irrespective of the material or culvert use.

This work consists of furnishing and installing pipe culverts, end sections, and headwalls.

The lengths shown on the plans are approximate. Do not order and deliver the culvert pipe until a list of sizes and lengths is furnished by the Engineer.

### MATERIALS

**601.02.01 General.** Material shall conform to the following Section or Subsections:

| | |
|---|---|
| Portland Cement Concrete | Section 501 |
| Portland Cement | Section 701 |
| Grout and Mortar Aggregate | Subsection 706.03.04 |
| Gaskets | Subsection 707.03.02 |
| Reinforced Concrete Pipe | Subsection 708.03.01 |
| Clay Pipe | Subsection 708.03.03 |
| Plastic Pipe | Subsection 708.03.04 |
| Corrugated Steel Pipe | Subsection 709.03.01 |
| Corrugated Aluminum Pipe | Subsection 709.03.02 |

Design pipes in conformance with the AASHTO Load and Resistance Factor Design (LRFD) Bridge Design Specifications.

### CONSTRUCTION

**601.03.01 Earthwork.** Excavation and backfill shall conform to Sections 206 and 207.

Bed pipe as shown in the plans. Use Class C bedding requirements unless specified otherwise. The lines and grades will be established.

The height of new embankments may be varied as directed before installing pipes in new embankments on a steep slope or in a difficult location.

**601.03.02 Headwalls.** Where shown on the plans, construct headwalls in connection with culvert pipes. Make the ends of the pipe flush with the headwall face. Construct headwalls according to Sections 501, 502, and 505.

**601.03.03 End Sections.** Excavate the bed for the end section to the required width and grade. For metal end sections with toe plates, excavate a trench for the toe plate in a manner to permit the toe plate to be against the inner face of the trench in its final position. After end sections have been properly secured to the pipe, backfill the trench and firmly compact.

Place the precast concrete end section with its tongue (or groove) fully entered in the groove (or tongue) of the pipe.

End sections installed on plastic pipes shall be designed to specifically fit the pipe. The end section shall engage a minimum of 2 pipe corrugations for exterior installations.

**601.03.04 Jacked Pipes.** Jack culvert pipe in place between the limits shown on the plans and conforming to the requirements of the respective Section for the pipe used.

The strength of pipe or wall thickness of pipe will be determined for vertical load only. Determine any additional reinforcement or strength required to withstand jacking pressure and furnish without additional compensation.

Submit a boring and jacking plan for approval describing the proposed equipment, materials, jacking loads, method of cushioning joints, and labor to be used to accomplish the work.

A factor of safety on axial load capacity shall be 2.22 (based on the ultimate strength of the concrete) for pipes installed by jacking methods. This assumes the load is uniformly distributed over the bearing surface. The effect of the eccentric and/or concentrated loadings on the pipe faces shall be evaluated for effective surface contact area and reduction in the factor of safety.

Do not exceed the pipe manufacturer's design jacking loads during the installation process.

Pipe showing signs of failure may be required to be jacked through to the reception pit and removed. Other methods of repairing the damaged conduit may be used, as recommended by the manufacturer and subject to approval.

The main jacking equipment shall have a jacking capacity greater than the anticipated jacking load.

Provide intermediate jacking stations when the total anticipated jacking force needed to complete the installation may exceed the capacity of the main jacks or the designed maximum jacking force for the pipe.

The jacking system shall develop a uniform distribution of jacking forces on the end of the pipe by the use of thruster rings and cushioning material.

A pipe lubrication system may be utilized when anticipated jacking forces on the pipe are expected to exceed the capacity of the main jacks or exceed the pipe design strength with the appropriate safety factor.

Construct jacking and receiving pits of a size meeting OSHA requirements and industry standards. With approval, the pits may be relocated to better suit the capabilities of the micro tunneling method proposed.

Before beginning, adequately protect existing structures, utilities, trees, shrubs and other permanent objects.

Do not exceed a variation from theoretical alignment and grade of more than 60 mm (0.2 ft) for each 6 m (20 ft) of pipe placed.

The diameter of the excavated hole shall not be more than 30 mm (0.1 ft) greater than the outside diameter of the pipe. Do not sluice and jet with water. When the material tends to cave in from outside these limits, use a shield ahead of the first section of pipe or do not extend the face of excavation beyond the end of the pipe more than 0.5 m (1.5 ft).

Fill voids resulting from caving or excavating outside the above limits with sand or grout.

Backfill and compact jacking pits to original condition after pipe installation.

**601.03.05 Laying Culvert Pipe.** Lay culvert pipe according to the requirements of the respective Section for the type of pipe used.

Do not place backfill until the pipe installation has been inspected.

If directed, dewater and remove debris and sediment from the pipe to allow for inspection.

The pipe will be inspected for unintended deflection, vertical and horizontal misalignment, leaking joints, cracking, spalling, slabbing, buckling, bulging, racking, and coating issues. Replace or re-lay unacceptable pipe.

**601.03.06 Extending Existing Culverts.** Extend existing culverts by the provisions for installing new culverts and the following additional provisions.

Furnish concrete, mesh and steel reinforcing, and epoxy as necessary to construct concrete collars for pipe extensions.

Leave the existing headwalls in place or demolish, remove, and dispose of as indicated on the plans. See Section 202.

Remove headwalls in such a manner as to prevent damage to the existing culvert. Repair or replace damaged culvert as directed.

## METHOD OF MEASUREMENT

**601.04.01 Measurement.** The materials to be paid for under these specifications will be listed in the contract items by size, class, type, plate thickness, or whatever information is necessary for identification.

Culvert pipe will be measured by the linear meter (linear foot) of pipe. Pipes cut to fit a structure or slope, will be measured by the linear meter (linear foot) of pipe necessary to be placed before cutting. Furnish pipe in appropriate lengths so as to minimize the length to be cut after placement. Excessive pipe lengths cut after placement, as determined by the Engineer, will not be measured for payment.

Culvert pipe bends, wyes, tees, and other branches will be measured by the linear meter (linear foot) for the sizes of pipes involved. Wyes, tees, eccentric reducers, and other branches will be measured as pipe along centerline to the point of intersection.

Structure excavation, backfill, Portland cement concrete, and reinforcement required for headwalls, endwalls, structures, and other items of work required to complete the work, will be measured as separate items as provided for under their respective Sections of these specifications. Structure excavation and backfill will not be measured on end sections.

End sections will be measured by the each.

No separate measurement or payment will be made for constructing jacking pits and backfilling all pits after the pipe is jacked, nor for excavation and backfill between the limits shown on the plans for jacking the pipe. Full compensation therefore will be considered as included in the price paid for jacked pipe.

## BASIS OF PAYMENT

**601.05.01 Payment.** The accepted quantities of culvert pipe, measured as provided above, will be listed under the respective Sections for the type of pipe used.

Full compensation for furnishing pipe with end finish, including distortion if required, will be considered as included in the price paid per linear meter (linear foot) for the pipe involved.

Full compensation for Class B and Class C bedding will be considered included in the price paid per cubic meter (cubic yard) for granular backfill.

Class A bedding will be paid for at the contract unit bid price per cubic meter (cubic yard) for Class A or AA concrete.

Provide for handling of whatever water is encountered at the site with no additional compensation allowed therefore.

# SECTION 603

## REINFORCED CONCRETE PIPE

DESCRIPTION

**603.01.01 General.** This work consists of furnishing and installing circular or oval shaped reinforced concrete pipe, siphons, and end sections.

MATERIALS

**603.02.01 General.** Material shall conform to Subsection 601.02.01 and the requirements specified herein.

Circular reinforced concrete pipe shall conform to AASHTO M170 for the specified diameters and strength classes.

Oval reinforced concrete pipe shall conform to AASHTO M207 for the specified rise and span for either vertical or horizontal elliptical pipe classes.

Flared end sections (precast) shall conform to the details and dimensions shown on the plans and except for shape, shall conform to the requirements of this Section for reinforced concrete pipe.

Tongue and groove joints and gasketed joints shall conform to Subsection 707.03.02.

Compose mortar of 1 part Portland cement and 2 parts mortar aggregate by volume. Add only enough water to permit placing and packing of the mortar.

Admixtures of hydrated lime, fire clay, diatomaceous earth, or other approved inert material may be used in the mortar to facilitate workability. Only add an approved amount of admixture.

CONSTRUCTION

**603.03.01 General.** Use construction methods conforming to Subsections 601.03.01 through 601.03.06 and the requirements in this Section.

Carefully handle concrete pipe in unloading, transporting, and laying.

Do not lay pipe which is cracked, checked, spalled, or damaged. Pipes which show defects due to handling will be rejected at the site of the installation regardless of prior acceptance.

**603.03.02 Earthwork.** When pipe having bells is used, excavate cross trenches for the bells to prevent nonuniform loading of the joints. Make the cross trenches not more than 50 mm (2 in.) wider than the width of the bell.

**603.03.03 Laying Culvert Pipe.** Suitably mark pipe with elliptical reinforcing to clearly indicate the top and bottom of the pipe.

Firmly place the first section of pipe at the outlet to the designated line and grade with the groove end or bell end pointing upgrade. Completely fill all handling holes in the pipes with grout.

Pipe shall be installed with tongue and groove joints or gasketed joints. Pipe specified to have watertight joints shall be installed with gasketed joints.

Install pipes, sealants, and gaskets as specified by the manufacturer. Submit a copy of the manufacturer's installation instructions prior to installation. Lubricate gaskets requiring lubricant with the lubricant recommended by the manufacturer.

Completely fill the outer and inner annular space between the laid pipe sections with mortar. Mortar will not be required if the space is 6 mm (1/4 in.) or less in width or the pipe diameter is less than 600 mm (24 in.). Where reinforced concrete collars or bells are used at the pipe joints, mortar will not be required in the outer annular space. Brush mortar smooth and remove all surplus mortar from inside the pipe.

**603.03.04 Siphons and Pressure Pipe.** Lay reinforced concrete pipe used for siphons or pressure pipe according to the above provisions. Use only gasketed joints. Perform the following hydrostatic test before backfilling:

Fill the pipe line with water at a hydrostatic head of 3 m (10 ft) above the highest point of the pipeline. Maintain the pressure head for a period of not less than 24 hours. Correct any visible leaks or other defects which develop during the test. Sweating that does not develop into a flow or drip will not be considered as leakage. Repeat the test until all leaks or other defects are eliminated.

## METHOD OF MEASUREMENT

**603.04.01 Measurement.** Measurement shall conform to Subsection 601.04.01 and the requirements specified herein.

Reinforced concrete pipe will be measured by the linear meter (linear foot).

Precast end sections will be measured by the each.

## BASIS OF PAYMENT

**603.05.01 Payment.** Payment shall conform to Subsection 601.05.01 and the requirements specified herein.

The accepted quantities, measured as provided above, will be paid for at the contract price per unit of measurement for the pay items listed below that are shown in the proposal. Payment will be full compensation for the work prescribed in this Section.

Payment will be made under:

| Pay Item | Pay Unit |
|---|---|
| (size) Reinforced Concrete Pipe (class) | Linear Meter (Linear Foot) |
| (size) Oval Reinforced Concrete Pipe (class) | Linear Meter (Linear Foot) |
| (size) Reinforced Concrete Siphon Pipe (class) | Linear Meter (Linear Foot) |
| (size) Reinforced Concrete Pipe (class) Jacked | Linear Meter (Linear Foot) |
| (size) Precast End Section | Each |

# SECTION 604

## CORRUGATED METAL PIPE AND METAL ARCH PIPE

### DESCRIPTION

**604.01.01 General.** This work consists of furnishing and installing corrugated metal pipe, corrugated metal arch pipes, and slotted corrugated metal pipe, and the relaying of old corrugated metal pipe and pipe arches.

### MATERIALS

**604.02.01 General.** Material shall conform to Subsection 601.02.01 and the requirements specified herein.

Corrugated metal pipe plate thickness determinations shown in the plans are based on steel pipe with 68 mm (2 2/3 in.) by 13 mm (1/2 in.) corrugations as indicated on the plan sheet entitled, “Allowable Fill Heights for Steel Culverts.”

The following pipes, conforming to the fill height tables shown in the plans, may be substituted for the 68 mm (2 2/3 in.) by 13 mm (1/2 in.) corrugated steel pipe:

(a) Corrugated steel pipe with 75 mm (3 in.) by 25 mm (1 in.) or 125 mm (5 in.) by 25 mm (1 in.) corrugations.

(b) Helical rib lock seam pipe (steel or aluminum) with 19 mm (3/4 in.) by 19 mm (3/4 in.) ribs at 190 mm (7 1/2 in.) or 19 mm (3/4 in.) by 25 mm (1 in.) ribs at 292 mm (11 1/2 in.).

(c) Corrugated aluminum pipe with 68 mm (2 2/3 in.) by 13 mm (1/2 in.), 75 mm (3 in.) by 25 mm (1 in.), or 150 mm (6 in.) by 25 mm (1 in.) corrugations.

Furnish the same type of pipe and end sections at each individual location. Fabricate the pipe and all accessories of the same material.

Plate thicknesses for coupling bands shall be as indicated in the plans.

Furnish metal end sections conforming to the details and dimensions shown on the plans and, except for shape, conforming to the requirements for corrugated metal pipe.

The following requirements pertain to the use of metal end sections:

(a) Finish the end of the new pipe with annular corrugations to conform to the metal end section.

(b) Use annular connector sections with new pipe.

(c) Use helical or annular connector sections to match existing pipe.

Ship and handle pipe in such a manner as to prevent bruising, scaling, or breaking of the galvanized coating. Repair any damaged galvanized coating in conformance with AASHTO M36. Repair may also be by thoroughly wire brushing the damaged area, removing all loose and cracked galvanized coating and painting with 2 coats of zinc oxide-zinc dust paint conforming to MIL-P-15145. Properly compound the paint in a suitable vehicle in the ratio of 1 part zinc oxide to 4 parts zinc dust by weight.

### CONSTRUCTION

**604.03.01 General.** Use construction methods conforming to Subsections 601.03.01 through 601.03.06 and the requirements in this Section.

**604.03.02 Laying Culvert Pipe.** Lay pipes upgrade. Lay pipe with outside laps of circumferential joints upgrade and longitudinal laps positioned other than in the invert. Place elongated pipes with major axis within 5° of vertical.

Join sections together with coupling bands bolted firmly in place.

Vertically elongate pipes 5% ± 1.25% before placement of fill. Elongate by approved jacking methods in the field or by prefabrication. Strutting of prefabricated elliptical pipe will not be required.

Strut uniformly from end to end of pipes where headwalls are not used. When headwalls are used, the amount of jacking and the length of struts may be reduced gradually under the side slopes of the embankment so that the ends of pipe at headwalls are circular. Leave the struts in place until the embankment is complete and compacted.

Lay pipes true to the designated line, grade, and camber. Fit and match pipes to form a smooth and uniform invert.

Use care in fitting sections of pipes together so that the joint openings will not be unnecessarily large.

**604.03.03 Siphons.** Close rivet and solder corrugated metal pipe for use as siphons and so fabricate as to require a minimum number of field connections. Space rivets on circumferential seams at approximately 63 mm (2 1/2 in.) centers with a maximum spacing of 75 mm (3 in.). Solder the circumferential and longitudinal seams on the outside of the pipe where the edges of the sheets lap. Sweat solder into the joints by means of a torch properly regulated for the purpose. Do not use soldering irons on factory seams.

Siphons shall also conform to the requirements for corrugated metal pipe culverts of this Section.

Use approved watertight couplings for field joints. To permit coupling bands to fit snugly into the corrugated ends of the pipe, omit rivets in the longitudinal seam and adequately solder.

Clean the ends of the pipe and the bands and install the gasket or mastic sealant material.

Completely fill the siphon with water and repair any leaks before backfilling.

**604.03.04 Slotted Drains.** Place slotted corrugated metal pipe drains flush with the pavement surface as indicated on the plans. Install the slotted drain flush with the top of the dense-graded bituminous surface before placing open-graded wearing course.

Saw cut pavement or cut pavement by approved means that will leave a clean, true vertical edge. Backfill the slotted drain with concrete as indicated on the plans. Place concrete neat (without forms) against the walls of the excavation.

## METHOD OF MEASUREMENT

**604.04.01 Measurement.** Measurement shall conform to Subsection 601.04.01 and the requirements specified herein.

Corrugated metal pipe will be measured by the linear meter (linear foot).

Metal end sections will be measured by the each.

Slotted corrugated metal pipe drain will be measured by the linear meter (linear foot). Structure excavation and concrete backfill will not be measured for payment on slotted corrugated metal pipe drains.

## BASIS OF PAYMENT

**604.05.01 Payment.** Payment shall conform to Subsection 601.05.01 and the requirements specified herein.

The accepted quantities, measured as provided above, will be paid for at the contract price per unit of measurement for the pay items listed below that are shown in the proposal. Payment will be full compensation for the work prescribed in this Section.

Payment will be made under:

| Pay Item | Pay Unit |
|---|---|
| (size) Corr. Metal Pipe (*) | Linear Meter (Linear Foot) |
| (size) Corr. Metal Pipe (*) Jacked | Linear Meter (Linear Foot) |
| (size) Corr. Metal Arch Pipe (*) | Linear Meter (Linear Foot) |
| (size) Metal End Section | Each |
| (size) Metal End Section (Safety Type) | Each |
| (size) Metal Arch End Section | Each |
| (size) Metal Arch End Section (Safety Type) | Each |
| (size) Slotted Corr. Metal Pipe Drain (*) | Linear Meter (Linear Foot) |

* Plate thickness

# SECTION 605

## PLASTIC PIPE

DESCRIPTION

**605.01.01 General.** This work consists of furnishing and installing plastic pipe.

MATERIALS

**605.02.01 General.** Material shall conform to Subsection 601.02.01 and the requirements specified herein.

Plastic pipe shall conform to Subsections 708.03.04 (a) Smooth Wall Polyethylene Pipe and (b) Corrugated Polyethylene Pipe.

Pipe shall be homogenous throughout and free of visible cracks, holes, foreign inclusions, or other defects. The pipe shall be uniform in color, opacity, density, and other physical properties. Compliance with the requirements of these specifications shall be certified in writing by the pipe supplier.

The dimensions of pipe shall be as shown on the plans and are in reference to nominal diameter unless otherwise indicated. Provide associated fittings that properly fit the pipe supplied. Provide pipe and fittings free from defects which would hinder their ability to function as designed.

CONSTRUCTION

**605.03.01 General.** Use construction methods conforming to Subsections 601.03.01 through 601.03.06 and the requirements in this Section.

Stockpile, handle, install, and firmly join pipe as specified by the manufacturer. Submit a copy of the manufacturer's installation instructions prior to installation. Lubricate gaskets requiring lubricant with the lubricant recommended by the manufacturer.

Pipe having any of the following damage will not be allowed for use: serious abrasion, cutting, or gouging of the inside or outside surface extending to more than 15% of the wall thickness in depth; kinking due to excessive or abrupt bending; flattening, particularly if localized over short lengths of the pipe amounting to more than 5% of the original diameter; and any abrasion or cutting of the inside surface.

**605.03.02 Laying Pipe.** Pipe laying shall begin at the downstream end of the pipeline except for extensions of existing pipes. Carefully lower pipe and accessories by means of derrick, ropes, belt slings, or other means per manufacturer's recommendations. Place the bottom of the pipe in contact with the shaped bedding throughout its full length. Place the female ends or outside circumferential laps of pipes facing upstream such that a shingling effect is obtained.

Maintain the manufacturer's recommended minimum and maximum cover at all times unless otherwise shown in the contract.

All pipe to pipe connections shall be bell and spigot, interlocking, or fusion welded connections for watertight installation. Watertight connections to drop inlets, metal end sections, box culverts, and other structures are not necessary unless specified. When specified, water tight connections to structures shall be made using a waterstop gasket or booted connection precast into the structure per manufacturers recommendations. Any repair or other connections of pipe to pipe which cannot be performed with an approved connection as listed above, shall require a concrete collar connection, approval of the Engineer, and shall maintain proper alignment and grade across the joint without displacement of pipes. The minimum pipe section length at the end of a pipe run terminating with a metal end section or headwall shall be 2.4 m (8 ft). Cut corrugated pipe to length at the center of nearest corrugation valley so as to not expose the annular space of the outer corrugation.

Do not place backfill until the pipe has been inspected. Ensure that no "floating" occurs during installation of culverts. Take up and relay or replace pipe found to be out of alignment, unduly settled, or damaged.

When cutting steel reinforced thermoplastic ribbed pipe, cut the pipe to length and protect the exposed reinforcing according to the manufacturer's specifications.

(a) Smooth Wall Polyethylene Pipe. Join pipe by the thermal fusion process according to ASTM F2620 and the manufacturer's specific recommendations or utilization of an interlocking joint system installed per the manufacturer's specifications. Pipe joining by the thermal fusion process shall be accomplished with qualified personnel. In order to allow the joining operation to continue in adverse weather conditions, build a shelter for the joining machine. Do not allow water or any other foreign materials to contact the heater plate or preheated pipe ends.

Pipe shall be brought to within 3 °C (5 °F) of earth temperature prior to making final length cuts at termination points to structures. All cuts shall be straight and neat.

**605.03.03 Deflection Testing.** Vertical deflections of pipe shall not exceed 5%. Test installed pipe by the mandrel requirements stated herein or other approved methods. Perform the test in the presence of the Engineer. Do not place base aggregate or plantmix pavement over pipe installations until deflection testing has been performed and is acceptable.

Perform deflection tests after pipe installation, backfill, and completion of earthwork to finished subgrade.

The mandrel shall be a rigid, nonadjustable, odd-numbered legged (minimum 9 legs) mandrel having a length not less than its nominal diameter. The minimum diameter at any point shall be 5% less than the nominal diameter of the pipe being tested. The mandrel shall be fabricated of steel, fitted with pulling rings at each end, stamped or engraved on some segment other than a runner with the nominal pipe size and mandrel outside diameter, and furnished in a suitable carrying case. The mandrel shall be approved before use. Use of an unapproved mandrel or a mandrel altered or modified after approval will invalidate the test.

The mandrel shall be pulled through by hand and shall move freely through the pipe without excessive force. If the mandrel fails to pass, the pipe is over deflected.

Remove and reinstall over deflected pipe and retest. Do not reinstall damaged pipe.

## METHOD OF MEASUREMENT

**605.04.01 Measurement.** Measurement shall conform to Subsection 601.04.01 and the requirements specified herein.

Polyethylene pipe will be measured by the linear meter (linear foot).

## BASIS OF PAYMENT

**605.05.01 Payment.** Payment shall conform to Subsection 601.05.01 and the requirements specified herein.

The accepted quantities, measured as provided above, will be paid for at the contract price per unit of measurement for the pay items listed below that are shown in the proposal. Payment will be full compensation for the work prescribed in this Section.

Payment will be made under:

| Pay Item | Pay Unit |
|---|---|
| (size) (type) Polyethylene Pipe | Linear Meter (Linear Foot) |

# SECTION 606

## STRUCTURAL PLATE CULVERTS

### DESCRIPTION

**606.01.01 General.** This work consists of furnishing and installing structural plate pipe, arches, and pipe arch culverts.

### MATERIALS

**606.02.01 General.** Material shall conform to Subsections 709.03.06 or 709.03.07.

Where an existing structural plate culvert is to be extended or otherwise modified, fabricate the plates and all accessories of the same material (steel or aluminum) as the existing.

The required thickness of the plates for each structure shall be specified in the contract documents. The thickness specified is for steel plate, aluminum plate of equivalent strength may be substituted.

The bottom plates for structural plate pipes and pipe arches shall be the next plate thickness larger than the thickness specified for the top and side plates. When 7.11 mm (0.280 in.) plate thickness is specified, the bottom plates shall also be 7.11 mm (0.280 in.).

Ship and handle plates in such a manner as to prevent bruising, scaling, or breaking of the galvanized coating.

Repair any damaged galvanized coating according to Subsection 604.02.01.

Design the steel structural plate pipe or the aluminum structural plate pipe according to AASHTO LRFD Bridge Design Specifications, Section 12, latest edition and supplements thereto. Submit design calculations and working drawings for structural plate structures for review and approval according to Subsection 105.02. Include on the working drawings the NDOT contract number, material designations, bill of materials, complete fabrication details, and assembly/installation guidelines including quality control measures to control loads, shape, and movement. Calculations and working drawings shall be prepared and stamped by a Nevada Registered Professional Civil Engineer.

The lengths and sizes shown in the plans are approximate. Do not order materials until the calculations and working drawings are approved.

### CONSTRUCTION

**606.03.01 Earthwork.** Excavation and backfill shall conform to Sections 206 and 207.

Lay the pipe in a trench excavated to the established lines and grades.

Grade and prepare the bottom of the trench to provide full contact with the pipe throughout its entire length.

The height of new embankments may be varied as directed before installing pipes in new embankments on a steep slope or in a difficult location.

Excavate and bed the pipe with compacted sand or compacted earth fill. The depth of the sand or compacted fill below the pipe shall not be less than one-third the inside diameter of the pipe with a minimum of 100 mm (4 in.) and a maximum of 300 mm (12 in.) with the exception that an extra 40 mm shall be added for every meter (1/2 inch for every foot) the trench exceeds 5 m (16 ft) in depth. Extend this bed at the sides of the pipe at least a distance of one-fourth the outside width of the pipe.

**606.03.02 Field Inspection.** Furnish an itemized statement of the number and length of the plates in each shipment by the manufacturer.

Furnish single plates in standard sizes to permit structure length increments of 600 mm (24 in.). If 25% or more of the plates in any shipment fail to conform to these specifications, the entire shipment may be rejected.

**606.03.03 Assembling.** Provide a copy of manufacturer's assembly instructions before assembly. The instructions shall show the position of each plate and assembly order.

Assemble the structural plate structures according to the manufacturer's assembly instructions.

Hold the unsupported edges of all plates in position by temporary props. Extend each row of side plates far enough to support the plate above until the first complete ring has been assembled. Progressively install a sufficient number of bolts to hold the plates in position. Do not tighten bolts until tightening will not interfere with the adjustment and matching of additional plates and sections. Exercise care in the use of drift pins or pry bars to prevent chipping or injury to the galvanized or other protective coating. Repair damaged coatings as set forth in Subsection 604.02.01.

After all plates are in place, progressively and uniformly tighten the bolts from one end of the structure. Repeat the tightening operation to be sure that all bolts are tight. Torque bolts to a minimum of (a) 135 N•m (100 ft-lb) for plates of 4.78 mm (0.188 in.) and lighter, and (b) 200 N•m (145 ft-lb) for plates of 5.54 mm (0.218 in.) and heavier. Recheck and retighten as necessary just before backfilling.

Install the elliptical-shaped pipes with their long diameter vertical. Install pipe arches with their span width horizontal.

**606.03.04 Strutting.** Timber strut vertically 3% out of round structural plate pipes, which are not fabricated out of round before erection, before placement of the embankment.

Deform the pipe to the required degree by means of suitable jacks by approved methods. A tolerance of 25% above or below the specified elongation will be permitted.

Uniformly strut the entire length of the pipe. Leave the struts in place until the embankment is complete and compacted, unless otherwise ordered.

In lieu of strutting, structural plate pipe may be furnished with the vertical axis fabricated out of round 5% of the nominal diameter. A tolerance of 25% above or below the specified elongation will be permitted. Make the elongation by approved shop methods. Satisfactorily repair or replace any coating damaged or destroyed.

**606.03.05 Workmanship.** The completed culvert shall show careful, finished workmanship in all particulars. Structural plates which show defective workmanship will be rejected. The presence of any of the following defects in any individual culvert plate, or in general in any shipment, shall constitute sufficient cause for rejection:

(a) Uneven laps.

(b) Variation from a straight centerline.

(c) Ragged edges.

(d) Loose, unevenly lined, or spaced bolts.

(e) Bruised, scaled, or broken galvanized coating. (See Subsection 604.02.01 for repair)

(f) Dents or bends in the metal itself.

**606.03.06 Headwalls and Footings.** Where shown on the plans, construct headwalls in connection with structural plate pipe. Make the ends of the pipe flush with the headwall face.

Construct footings in connection with structural steel arches. Rest each side of the structural plate arches on a galvanized metal angle or channel bearing, securely anchored to the footing and capable of resisting the arch thrust without damage to said angle or channel.

Construct headwalls and footings according to Sections 501 and 502.

**606.03.07 Extending Existing Structural Plate Culverts.** When extending existing structural plate culverts, make the connection of the old and new sections by punching any necessary bolt holes, furnishing bolts, nuts and washers, changing location of individual plates, and any other work required in the completion of the connection. Where an existing headwall is in place, completely remove the headwall according to Section 202.

## METHOD OF MEASUREMENT

**606.04.01 Measurement.** Structural plate pipe, arches, or pipe arches will be measured by the linear meter (linear foot). The number of linear meters (linear feet) shall be the average of the top and bottom centerline lengths for structural plate pipe or pipe arches.

Structure excavation, backfill, Portland cement concrete and reinforcement required for headwalls, footings, structures, and other items required to complete the work will be measured and paid for under their respective Sections of these specifications.

## BASIS OF PAYMENT

**606.05.01 Payment.** The accepted quantities, measured as provided above, will be paid for at the contract price per unit of measurement for the pay items listed below that are shown in the proposal. Payment will be full compensation for the work prescribed in this Section.

Provide for handling whatever water is encountered at the site with no additional compensation allowed therefore.

Payment will be made under:

| **Pay Item** | **Pay Unit** |
|---|---|
| (size) Structural Plate Pipe | Linear Meter (Linear Foot) |
| (size) Structural Plate Pipe Arch | Linear Meter (Linear Foot) |
| (size) Structural Plate Arch | Linear Meter (Linear Foot) |

# SECTION 607

## UNDERDRAINS

### DESCRIPTION

**607.01.01 General.** This work consists of constructing underdrains using pipe, drain backfill, and geotextile.

### MATERIALS

**607.02.01 General.** Material shall conform to the following Subsections and Section:

| | |
|---|---|
| Portland Cement | Section 701 |
| Drain Backfill | Subsection 704.03.01 |
| Grout and Mortar Aggregate | Subsection 706.03.04 |
| Perforated Concrete Pipe | Subsection 708.03.02 |
| Clay Pipe | Subsection 708.03.03 |
| Corrugated Polyethylene Drainage Pipe | Subsection 708.03.04 (d) |
| Smooth Wall Polyvinyl Chloride Pipe | Subsection 708.03.04 (e) |
| Corrugated Steel Pipe for Underdrains | Subsection 709.03.04 |
| Corrugated Aluminum Pipe for Underdrains | Subsection 709.03.05 |
| Engineering Fabrics | Section 731 |

Underdrain pipe may be corrugated steel, corrugated aluminum, concrete, clay, corrugated polyethylene, or smooth wall polyvinyl chloride pipe.

Assemble each separate underdrain installation from one material only. Metal pipe plate wall thickness shall be 1.6 mm (16 gage) for steel and 1.5 mm (16 gage) for aluminum unless otherwise noted on the plans.

Submit in writing, 2 weeks in advance of the preconstruction conference, the type of underdrain pipe to be furnished. No changes will be allowed to the type of material chosen.

The lengths shown on the plans are approximate. Do not order and deliver the pipe until a correct list of sizes and lengths is furnished by the Engineer.

Ship and handle pipes in such a manner as to prevent bruising, scaling, or breaking. Repair any damaged galvanized coating according to Subsection 604.02.01. Do not lay any pipe which is cracked, checked, spalled, or damaged.

### CONSTRUCTION

**607.03.01 Earthwork.** Excavation and drain backfill shall conform to Sections 206 and 209 respectively with the following modifications:

(a) Excavate trenches to the dimensions and grade required.

(b) Place geotextile at locations shown on the plans and in accordance with Section 610.

(c) Place a minimum 75 mm (3 in.) bedding layer of drain backfill material in the bottom of the trench for its full width and length, and bring to a uniform grade.

(d) If an item for grouting drain backfill is shown in the proposal, cover drain backfill with a thick grout not less than 25 mm (1 in.) in thickness. Compose the grout of 1 part Portland cement and 5 parts grout aggregate, by volume. Mix grout materials to a suitable consistency. Use grout within 30 minutes after the addition of water. Thoroughly tamp grout to provide an impervious layer over the entire surface of the drain backfill.

**607.03.02 Laying Pipes.** Lay bell and spigot concrete or clay pipe upgrade with the bell end upgrade and the spigot end not quite fully entered in the adjacent bell. Lay pipe true to line and grade with a uniform bearing under the full length of the barrel. Cover the pipe joints with 2 ply tar paper strips not less than 150 mm (6 in.) in width and of sufficient length to permit the ends to be turned outward and laid flat on the bottom course of drain backfill on either side of the pipe for a distance of 75 mm (3 in.).

When pipe does not have perforations around the full circumference, lay with the perforations at the bottom of the pipe. Firmly bed the pipe throughout its length.

Join metal pipe sections with band couplers. Join corrugated polyethylene pipe sections by snap couplers, split couplers, or spin-on couplers as recommended by the manufacturer.

Join concrete and clay pipe sections with external bands of mortar placed around the pipe joints as herein specified. Join several sections of pipe before commencing banding operations, but do not let the placing of external bands be more than 5 lengths of pipe behind joining operations.

Immediately in advance of placing external band mortar, thoroughly clean and wet the external surface of the pipe sections at the joint to insure proper bonding of the band mortar with the pipe. Exercise care to make a union between the band and the mortar which was placed under the joint before the pipe sections were abutted. Make the band not less than 13 mm (0.5 in.) thick at the pipe joint and approximately 100 mm (4 in.) wide, overlapping the abutting ends of the pipe sections approximately 50 mm (2 in.). The edges of the band shall adhere to the pipe surface to prevent peeling. Finish in a workmanlike manner.

Lay pipe with all ends firmly joined. Install joints such that the connection of pipe sections form a continuous line free of irregularities in the flow line.

After inspection and approval of the pipe installation, backfill the trench.

## METHOD OF MEASUREMENT

**607.04.01 Measurement.** Quantities shown on the plans are based on corrugated metal pipe. No adjustment of quantities will be made due to use of other types of pipe.

Underdrain pipe will be measured by the linear meter (linear foot). Bends, wyes, tees, and other branches will be measured as pipe along centerlines to the point of intersection.

Grouted drain backfill will be measured by the linear meter (linear foot) along the longitudinal axis of the drain.

Structure excavation, drain backfill, and geotextile will be measured and paid for as separate items as provided in Sections 206, 209, and 610.

## BASIS OF PAYMENT

**607.05.01 Payment.** The accepted quantities, measured as provided above, will be paid for at the contract price per unit of measurement for the pay items listed below that are shown in the proposal. Payment will be full compensation for the work prescribed in this Section.

Provide for handling whatever water is encountered at the site with no additional compensation allowed therefore.

Payment will be made under:

| Pay Item | Pay Unit |
|---|---|
| (size) Perforated Pipe | Linear Meter (Linear Foot) |
| (size) Nonperforated Pipe | Linear Meter (Linear Foot) |
| Grouting Drain Backfill (width) | Linear Meter (Linear Foot) |

# SECTION 608

## DOWNDRAINS

### DESCRIPTION

**608.01.01 General.** This work consists of furnishing and installing embankment protectors, downdrain pipe, anchor assemblies, metal end sections, geotextile, and riprap.

Lengths of downdrain pipe shown on the plans are approximate. Do not order and deliver the downdrain pipe until it is staked in the field and a list of lengths and pipe angles is furnished by the Engineer.

### MATERIALS

**608.02.01 General.** Material shall conform to the following Sections and Subsections:

| | |
|---|---|
| Portland Cement Concrete | Section 501 |
| Reinforcing Steel | Section 505 |
| Riprap | Section 610 |
| Smooth Wall Polyethylene Pipe | Subsection 708.03.04 (a) |
| Corrugated Polyethylene Pipe | Subsection 708.03.04 (b) |
| Corrugated Steel Pipe | Subsection 709.03.01 |
| Corrugated Aluminum Pipe | Subsection 709.03.02 |
| Anchor Assemblies for Downdrains | Subsection 709.03.03 |
| Geotextile (Class 2) | Subsection 731.03.03 |

Downdrain pipe may be corrugated steel, corrugated aluminum, or one of the plastic types specified above.

Metal pipe plate thickness shall be 1.6 mm (16 gage) for steel and 1.5 mm (16 gage) for aluminum unless otherwise noted on the plans.

Except as hereinafter provided, assemble each separate downdrain installation from one material only.

Electrically insulate anchor assemblies used with an aluminum installation.

Connect plastic pipe to metal end sections according to the manufacturer's recommendations.

Repair any damaged galvanized coating on corrugated steel parts according to Subsection 604.02.01.

Metal end sections shall conform to the details and dimensions shown in the plans and, except for shape, shall conform to the requirements for corrugated metal pipe.

Metal grates and frames shall conform to Section 609.

### CONSTRUCTION

**608.03.01 General.** Structure excavation and backfill shall conform to Sections 206 and 207.

Construct concrete inlet structures according to Sections 501 and 502.

Construct riprap apron as shown on the plans.

Connect metal pipe sections by means of band couplers. Connect plastic pipe sections according to Section 605.

### METHOD OF MEASUREMENT

**608.04.01 Measurement.** Embankment protectors, metal end sections, and anchor assemblies will be measured by the each.

Downdrain pipe will be measured by the linear meter (linear foot).

Structural steel grates for embankment protectors will be measured and paid for according to Section 609.

Pipe elbows, wyes, tees, and other branches will be measured and paid for by the linear meter (linear foot) for the size and type of pipe involved. Wyes, elbows, tees, and other branches will be measured as pipe along centerlines to the point of intersection.

Structure excavation, granular backfill, geotextile, and riprap shall be considered as included in the price paid for other items of work in this Section, and no separate payment will be made therefore.

BASIS OF PAYMENT

**608.05.01 Payment.** The accepted quantities, measured as provided above, will be paid for at the contract price per unit of measurement for the pay items listed below that are shown in the proposal. Payment will be full compensation for the work prescribed in this Section.

Payment will be made under:

| Pay Item | Pay Unit |
|---|---|
| Embankment Protector (type) | Each |
| Anchor Assembly (size) | Each |
| (size) Downdrain Pipe | Linear Meter (Linear Foot) |
| (size) Metal End Section (Downdrain) | Each |

# SECTION 609

## INLETS AND MANHOLES

### DESCRIPTION

**609.01.01 General.** This work consists of constructing or reconstructing inlets, manholes, and similar structures.

### MATERIALS

**609.02.01 General.** Material shall conform to the following Sections and Subsections:

| | |
|---|---|
| Portland Cement Concrete | Section 501 |
| Reinforcing Steel | Section 505 |
| Grout and Mortar Aggregate | Subsection 706.03.04 |
| Miscellaneous Metal | Section 712 |
| Gray Iron Castings | Subsection 712.03.02 |

Portland cement concrete shall be Class A or Class AA unless otherwise provided.

Precast manhole materials shall conform to AASHTO M199 (ASTM C478). Tongue and groove joints and gasketed joints shall conform to Subsection 707.03.02.

Concrete for concrete collars placed around manholes, valves, covers, etc., shall be a fast-setting concrete when required as specified in Subsection 609.03.02. Use fast-setting concrete products listed in the QPL.

Mix mortar for setting grates in the proportions of 1 part Portland cement to 3 parts of mortar aggregate by volume. Add only enough water to permit placing and packing of the mortar.

Supply castings true to pattern in form and dimensions, free from pouring faults, sponginess, cracks, blow holes, and other defects in positions affecting strength and value for the service intended. Boldly fillet at angles and make sharp and perfect arrises in castings. Sand blast or otherwise effectively clean castings of scale and sand so as to present a smooth, clean, and uniform surface.

Castings of frames, grates, rings, and covers for inlets, manholes, and other structures shall meet H-20 loading requirements according to AASHTO M306.

Pipe crossbars for drop inlets shall be standard weight black pipe conforming to ASTM A53.

Structural steel for grates and frames for drop inlets shall conform to ASTM A36.

Do not paint or galvanize grates, frames, or castings.

### CONSTRUCTION

**609.03.01 General.** Construct inlets and manholes according to Section 502. Place inlet and outlet pipes before pouring concrete.

Manhole sections shall be installed with tongue and groove joints or gasketed joints. Manholes specified to have watertight joints shall be installed with gasketed joints. Install manhole sections, sealants, and gaskets as specified by the manufacturer. Submit a copy of the manufacturer's installation instructions prior to installation. Lubricate gaskets requiring lubricant with the lubricant recommended by the manufacturer.

Precast inlets and manholes that require the diversion of public traffic during their construction. Do not begin excavations required for such structures until the structures have been precast, cured, and are ready for installation. Once installation has been commenced, continuously work on a working day by working day basis thereon until such time as public traffic is allowed the use of the area as approved.

For restrictions on when to construct inlets or manholes to final grade see Subsection 613.03.06.

Set grates in full mortar beds or otherwise secure as shown on the plans. Set grates accurately to the final elevations. Construct concrete covers to fit snugly and be readily removable.

Extend pipe for inlet or outlet connections through the walls and beyond the outside surfaces of the walls a sufficient distance to allow for connections. Make joints waterproof around the outer surfaces of such pipe.

Commercially prefabricated frames and grates of equal or greater capacity and strength may be substituted for the design shown on the plans for inlets provided prior approval is obtained in writing.

Matchmark frames and grates in pairs before delivery to the work. Grates shall fit into their frames without rocking.

Where pipe grates are designated for use, substitution of other type grates will not be permitted.

**609.03.02 Adjusting Manhole and Valve Covers.** Adjust existing manhole, valve, and meter covers, etc., where indicated on the plans and as directed. The concrete collar required for adjusting covers is shown in the Standard Plans. Replace existing collars with concrete collars of the same size or replace the roadway structural section, matching the existing thicknesses, prior to placement of a minimum size collar. Use materials meeting the requirements of Sections 302 and 402.

Prior to paving, when adjusting by Method A, or lowering covers, when adjusting by Method B, document offset ties to all utility covers to be adjusted. Include sufficient detail to ensure recovery of these locations following paving operations. Submit this documentation on a daily basis prior to paving and cover lowering operations. Clearly mark cover locations on the new surface immediately following paving operations and maintain these marks until the adjustments are complete.

Adjust by the following methods:

Method A. Use this method when removal of the existing pavement by cold milling is not required. Pave over the cover. Once all paving is completed, locate and adjust the cover to the final finished pavement level. Prevent paving materials from entering any openings in the cover.

Method B. Use this method when removal of the existing pavement by cold milling is required. Before cold milling, lower the cover sufficiently to accommodate the required pavement removal depth. If the lowered cover presents a hazard to public safety, provide protection therefrom in an approved manner. In lieu of replacing a manhole cover, use a steel plate of sufficient width and a minimum thickness of 16 mm (5/8 in.) to cover the lowered manhole. Once pavement removal has been completed, and the new pavement placed and completed, locate and adjust the cover to the final pavement level. Prevent existing or new paving materials from entering any openings in the cover.

Method C. Use this method of adjustment outside the areas described in Methods A and B of this Subsection. Adjust covers to the required elevation.

Adjusting covers or lids to the required elevation by the above methods shall require removing such existing concrete collars and covers and adjusting the top of the existing structures by removing or adding concrete, grade rings, brick masonry, or concrete block masonry, as the case may be, and reinstalling the fixtures firmly in place.

Thoroughly compact the base or backfill material under the concrete collars around manholes and valves to not less than 90% of maximum density as determined by Test Method No. Nev. T108. The in-place density will be determined by Test Method No. Nev. T102 or T103.

The use of fast-setting concrete in lieu of Class A or Class AA concrete for concrete collars on adjusting covers by Method A or B may be required if the traveled way must be opened to traffic within a short period of time.

Do not place traffic on concrete collars until the compressive strength of the concrete has reached a minimum of 14 MPa (2,000 psi), as measured by Test Method ASTM C39.

Use the fast-setting concrete according to the manufacturer's recommendations. Do not use aggregate to extend fast-setting concrete. Furnish a copy of the manufacturer's installation recommendations before beginning the installation.

Repair any cracks which occur in the fast-setting concrete.

Perform adjustments to meet the straightedge requirements of Subsection 402.03.05.

**609.03.03 Clean Out.** Thoroughly clean all inlets, manholes, and similar structures of any accumulations of silt, debris, or foreign matter of any kind. Also remove any such accumulations at the time of final inspection.

**609.03.04 Earthwork.** Perform structure excavation and backfill as necessary to construct structures. Structure excavation and backfill shall conform to Sections 206 and 207.

## METHOD OF MEASUREMENT

**609.04.01 Measurement.** Castings and structural steel grates will be measured by the kilogram (pound). The mass of castings will be computed from the dimensions shown on the approved shop drawings, based on a cast iron mass of 7,200 kg/m$^3$ (450 lb/ft$^3$), with an allowance of 10% for fillets and overrun. The mass of structural steel grates will be computed from the dimensions shown on the approved shop drawings, according to Section 506. Certified shop masses will be acceptable in lieu of computed masses.

Pipe crossbars and straps for inlets will be included in the measurement by the kilogram (pound) for structural steel grates.

Adjusting covers will be measured by the each.

Manholes will be measured by the each. Castings for manholes will be measured as set forth above.

Structure excavation, backfill, Portland cement concrete, and reinforcing steel used in new structures of inlets will be measured and paid for as separate items as provided for under their respective Sections of these specifications. Structural steel grates for inlets will be measured as set forth above.

Pipe riser inlets will be measured by the each. Structural steel grates for pipe riser inlets will be measured as set forth above.

## BASIS OF PAYMENT

**609.05.01 Payment.** The accepted quantities, measured as provided above, will be paid for at the contract price per unit of measurement for the pay items listed below that are shown in the proposal. Payment will be full compensation for the work prescribed in this Section.

Payment will be made under:

| Pay Item | Pay Unit |
|---|---|
| Castings | Kilogram (Pound) |
| Structural Steel Grates | Kilogram (Pound) |
| (type) Manhole | Each |
| (type) Manhole (Modified) | Each |
| Adjusting (type) Covers (method) | Each |
| Pipe Riser Inlet (type) | Each |

# SECTION 610

## RIPRAP

### DESCRIPTION

**610.01.01 General.** This work consists of furnishing and placing riprap (with or without grout), riprap bedding, and geotextile.

### MATERIALS

**610.02.01 General.** Material shall conform to the following Sections and Subsections:

| | |
|---|---|
| Portland Cement | Section 701 |
| Grout and Mortar Aggregate | Subsection 706.03.04 |
| Stone for Riprap | Subsection 719.03.01 |
| Aggregate for Riprap Bedding | Subsection 719.03.02 |
| Water | Section 722 |
| Engineering Fabrics | Section 731 |

Compose grout of 1 part Portland cement and 3 parts grout aggregate by volume.

### CONSTRUCTION

**610.03.01 Earthwork.** Make surfaces to be protected by riprap free of brush, stumps and other objectionable materials and dress to a smooth surface. Remove any soft or spongy material as directed and replace with approved native material. Compact filled areas as specified for embankments in Section 203.

Excavations for riprap beds shall conform to Sections 203 and 206. Excavations for trenches, footings, cutoff walls, etc., shall conform to Section 206. Gradation and compaction requirements on backfill will not apply.

When shown on the plans, place a bedding layer or filter on the prepared surface as specified before the riprap is placed.

**610.03.02 Riprap.** Place stone for riprap on the prepared surface by hand or mechanical means in a manner which will produce a well graded mass of stone with a minimum practicable percentage of voids. Place the stone so as to be in close conformity with the details shown on the plans.

Place riprap to its full course thickness in one operation and in such a manner as to avoid displacement of the underlying material. Do not place riprap in layers, or by dumping into chutes, or by similar methods likely to cause segregation.

Produce a fairly compact riprap course in which all sizes of material are evenly distributed and placed in their proper proportions. Hand placement or rearrangement of individual stones by mechanical equipment may be required to secure the results specified.

Replace any material displaced by any cause to the lines and grades shown on the plans.

**610.03.03 Grouted Riprap.** This stone shall conform to the requirements of Subsection 719.03.01 except that gradation and grout penetration depth requirements shall be as specified in the Special Provisions.

Place stone by hand or mechanical means that will produce a well graded, uniform rock blanket in close conformity with the details shown on the plans. The finished face shall present an even, tight surface.

The rock to be grouted shall be basically free of fines in order that penetration of the grout can be achieved.

Wet the rock immediately prior to commencement of the grouting operation. Fill the space between the stones with grout to the depth specified. Use sufficient grout of a consistency to completely fill all voids, except leave face stones exposed to 1/4 to 1/3 their depth. Transport the grout to the place of final deposit by use of chutes, tubes, buckets, pneumatic equipment, or any other mechanical method which will control segregation and uniformity of the grout. Use spading and rodding where penetration is achieved by gravity flow into the interstices.

Cure the grouted surface as specified in Subsection 501.03.08 for a period of at least 3 days.

**610.03.04 Riprap Bedding.** Uniformly place the riprap bedding material on the prepared surface by hand or mechanical means in a manner which will produce a well graded mass of material with the minimum practicable percentage of voids. Place the bedding so as to be in close conformity with the details shown on the plans.

Place riprap bedding to its full course thickness in one operation and in such a manner as to avoid displacement of the underlying material. Do not place riprap bedding in layers, or by dumping into chutes, or by similar methods likely to cause segregation. Produce a fairly compact riprap bedding layer in which all sizes of material are evenly distributed and placed in their proper proportions.

Replace any material displaced by any cause to the lines and grades shown on the plans.

**610.03.05 Geotextile.** Grade the area to receive the geotextile to an even, smooth surface that is free of cavities, large stones, or other debris capable of puncturing or tearing the geotextile.

Use equipment for installation that is recommended by the manufacturer and approved.

Unroll and place the geotextile parallel to the direction of water flow. Place the geotextile in intimate contact with the soil without wrinkles or folds. Use care to ensure that the geotextile is not damaged by the installation procedures. Avoid smearing the geotextile with mud or contaminating it with other foreign substances. Place the geotextile so that backfilling operations do not tear or excessively stretch the fabric.

Join adjacent sheets and roll ends together by overlapping or sewing.

If adjacent sheets and roll ends are overlapped, overlap upslope sheets over downslope sheets and upstream sheets over downstream sheets. Overlap roll ends and adjacent sheets a minimum of 0.3 m (1 ft) unless placed underwater or on slopes steeper than 2:1 (H:V). Increase roll ends and adjacent sheet overlaps to a minimum of 1 m (3 ft) when the geotextile is installed underwater or on slopes steeper than 2:1 (H:V). Maintain a minimum offset of 1.5 m (5 ft) between adjacent overlapped or sewn roll ends. Do not pin or staple geotextile sheets together to maintain overlaps during construction on slopes steeper than 2:1 (H:V).

If adjacent sheets and roll ends are sewn, use a polypropylene or polyester thread with a color contrasting to the geotextile. Submit a seam assembly description including seam type, stitch type, sewing thread, and stitch density along with seam samples. Provide a certificate of compliance to verify that the seam strength meets a minimum of 90% of the required grab strength of the geotextile.

Limit atmospheric exposure of the uncovered geotextile to 10 days to minimize damage potential due to sunlight, rain, dirt, and contamination.

Before covering, the geotextile will be inspected to determine that there are no holes, tears, folds, wrinkles, or contaminated areas. Repair holes or tears by placing a new layer of geotextile extending beyond the defect at least 0.3 m (1 ft) in all directions. Remove and replace contaminated areas with new geotextile.

Place the geotextile and backfill materials on the same day during underwater installations.

Do not drive vehicles or construction equipment directly on the geotextile. Place a minimum thickness of 200 m (8 in.) of riprap bedding on top of the geotextile before operating vehicles or construction equipment over the geotextile. Do not turn construction vehicles on the first backfill lift placed on top of the geotextile.

Place riprap bedding by dumping from the edge of the geotextile or from previously placed lifts of riprap bedding. Do not drop riprap bedding or riprap from a distance higher than 1 m (3 ft) above the geotextile. Place riprap stones 450 mm (18 in.) in diameter or larger without free fall. On slopes, place riprap and riprap bedding from the toe and proceed up the slope. Perform field monitoring to ensure that the armor system placement procedures do not damage the geotextile. When directed, remove riprap and riprap bedding at any location to allow for inspection of the geotextile for damage. Reinstall bedding and riprap at inspected areas.

Submit proposed installation procedures for underwater applications for approval a minimum of 14 days prior to construction. Include specific details addressing how geotextile damage inspection and minimum geotextile overlap requirements will be satisfied.

Conduct field trials to demonstrate that any proposed alternate construction procedures are suitable for revetment construction prior to approval. Any damage to the geotextile inflicted during field trials shall be mitigated by repairing or replacing as described above.

## METHOD OF MEASUREMENT

**610.04.01 Measurement.** Riprap, grouted riprap, and riprap bedding will be measured by the cubic meter (cubic yard).

Excavations for riprap beds will be measured and paid for according to Sections 203 and 206. Structure excavation for riprap trenches, footings, cutoff walls, etc., will be measured and paid for according to Section 206. Backfill shall be considered as included in the price paid for structure excavation and no separate payment will be made therefore.

Geotextile will be measured by the square meter (square yard). No allowance will be made for material overlap.

## BASIS OF PAYMENT

**610.05.01 Payment.** The accepted quantities, measured as provided above, will be paid for at the contract price per unit of measurement for the pay items listed below that are shown in the proposal. Payment will be full compensation for the work prescribed in this Section.

Payment will be made under:

| **Pay Item** | **Pay Unit** |
|---|---|
| Riprap (class) | Cubic Meter (Cubic Yard) |
| Grouted Riprap | Cubic Meter (Cubic Yard) |
| Riprap Bedding (class) | Cubic Meter (Cubic Yard) |
| Geotextile (class) | Square Meter (Square Yard) |

# SECTION 611

## CONCRETE SLOPE PAVING

DESCRIPTION

**611.01.01 General.** This work consists of constructing concrete slope paving.

MATERIALS

**611.02.01 General.** Material shall conform to the following Section and Subsection:

Portland Cement Concrete ..... Section 501
Grout and Mortar Aggregate ..... Subsection 706.03.04

Concrete shall be Class A or Class AA concrete as shown in the proposal. Class D may be substituted for Class A concrete or Class DA may be substituted for Class AA concrete.

In addition to the requirements of Section 501, include the proposed fibers to be used in the trial batches for mix design approval except as follows:

> For concrete slope paving quantities of 30 $m^3$ (40 $yd^3$) or less, the addition of fibers in the trial batches for mix design approval is waived.

Follow the manufacturer's recommendation for the addition of Type I and Type II fibers. For Type III synthetic or polypropylene fibers, add at a rate of 0.89 $kg/m^3$ (1.5 $lb/yd^3$) of concrete.

Header boards consisting of 38 mm by 89 mm (Standard 2 x 4) redwood lumber shall be commercial grade heart redwood, S4S.

Nails used in construction of header boards shall be commercial quality galvanized nails.

**611.02.02 Fibrous Concrete Reinforcement.** (a) Fiber Types. The fiber reinforcement shall conform to the classifications of Type I Steel Fiber, Type II Glass Fiber, or Type III Synthetic Fiber as described in ASTM C1116.

Select steel fibers, glass fibers, or synthetic fibers with physical and chemical properties recommended in ACI 544.1R.

(b) Certificates. Ascertain that all required tests have been made by approved testing laboratories.

Furnish a written certification that all required tests have been satisfactorily completed and that the materials and fabrication thereof comply with all the requirements.

CONSTRUCTION

**611.03.01 Earthwork.** Form the subgrade for paved ditches and slope paving by excavating to the required depth below the prepared finish surface grade.

Compact the subgrade to not less than 95% of the maximum density as determined by Test Method No. Nev. T108. The in-place density will be determined by Test Method No. Nev. T102 or T103.

Remove any soft, spongy, or other unsuitable material to such depth as directed and backfill with suitable material and compact.

Sprinkle water on the subgrade during compaction.

Sufficiently moisten the subgrade before placing concrete to prevent absorption.

Excavations for slope paving, trenches, footings, cutoff walls, etc., shall conform to Sections 203 and 206. Gradation and compaction requirements on backfill will not apply.

**611.03.02 General.** Install header boards to conform to the grades of the slope paving, to the dimensions, spaces, and layout shown on the plans. Hold header boards in position with stakes of suitable size and length as shown on the plans.

Construct slope paving with expansion joints where shown on the plans.

Do not place slope paving against frosted or frozen surfaces.

Add integral color pigment to all concrete or mortar surfaces for slope paving, except that used in ditch lining. The color pigment shall consist of a synthetic mineral oxide specifically manufactured for coloring concrete. Obtain the integral concrete coloring by mixing the pigment material with the Portland cement, aggregates, fibers, and water in a sequence and by methods that will result in a uniform mixture.

The color of the finished slope paving surfaces shall conform to Federal Standard Color No. 30324 as shown in Table I of Federal Standard No. 595B. Minor deviations in color and tint will be acceptable.

Before placing slope paving, construct sufficient test panels of at least 1.2 m (4 ft) by 1.8 m (6 ft) for approval of the proper color and texture. Construct the panels at the construction site and place by the method to be used in placing slope pavement.

Add fibrous concrete reinforcement to concrete materials at the time the concrete is batched in amounts in accord with the approved mix designs for slope paving. Mix concrete in strict accord with fiber reinforcement manufacturer's instructions and recommendations for uniform and complete distribution.

Tamp concrete, after spreading, until it is thoroughly compact and mortar flushes to the surface. If the slope is too steep to permit the use of concrete sufficiently wet to flush with tamping, the concrete may be tamped until consolidated and a mortar surface 6 mm (1/4 in.) thick troweled on immediately. The mortar shall consist of 1 part Portland cement and 3 parts of mortar aggregate by volume. The mortar surface shall be considered as a part of the concrete.

After striking off to grade, hand float the concrete with wooden floats not less than 100 mm (4 in.) in width and not less than 750 mm (30 in.) in length. Take care to prevent rotary marks of the hand floats.

Edge joints with a 6 mm (1/4 in.) radius edger before brooming the surface.

Broom the entire surface with a fine texture hair push broom to produce a uniform surface and eliminate float marks. Broom when the surface is sufficiently set to prevent deep scarring and accomplish by drawing the broom down the slope leaving the marks parallel to the edges of the panel.

Protect concrete during placing and curing as set forth in Section 501.

## METHOD OF MEASUREMENT

**611.04.01 Measurement.** Concrete slope paving, including concrete aprons and cutoff walls, will be measured by the cubic meter (cubic yard).

The quantity will be computed from measurements of the actual areas placed based on the theoretical thickness shown on the plans.

## BASIS OF PAYMENT

**611.05.01 Payment.** The accepted quantities, measured as provided above, will be paid for at the contract price per unit of measurement for the pay item listed below that is shown in the proposal. Payment will be full compensation for the work prescribed in this Section.

Payment will be made under:

| Pay Item | Pay Unit |
|---|---|
| (class) Concrete Slope Pavement | Cubic Meter (Cubic Yard) |

# SECTION 613

## CONCRETE CURBS, GUTTERS, AND SIDEWALKS

### DESCRIPTION

**613.01.01 General.** This work consists of constructing curbs, gutters, sidewalks, ramps, local depressions, driveways, and detectable warnings.

### MATERIALS

**613.02.01 General.** Material shall conform to the following Sections:

| | |
|---|---|
| Portland Cement Concrete | Section 501 |
| Concrete Structures | Section 502 |
| Reinforcing Steel | Section 505 |

Concrete shall be Class A or Class AA concrete as shown in the proposal. Class D may be substituted for Class A concrete or Class DA may be substituted for Class AA concrete.

The epoxy adhesive used to bond concrete curbs to new or existing pavements shall conform to AASHTO M235 (ASTM C881), Type I, Grade 1, 2, or 3 — Class A, B, or C.

Use detectable warnings listed in the QPL. Red colored detectable warnings shall be installed in concrete surfaces. Green colored detectable warnings shall be installed in asphalt surfaces.

### CONSTRUCTION

**613.03.01 Earthwork.** Construct the subgrade true to grade and cross section. Water and roll or hand tamp subgrade to the required compaction for the adjacent roadway or base course.

Remove all soft and spongy material to a depth of not less than 150 mm (6 in.) below subgrade elevation for curbs, gutters, local depressions, and driveways and 75 mm (3 in.) below for sidewalks. Fill the resulting space with earth, sand, or gravel of a quality that, when moistened and rolled or tamped, will form a firm and solid foundation.

Test the completed subgrade for grade and cross section by means of a template extending the full depth and supported on the side forms.

Thoroughly water the subgrade and forms in advance of placing concrete.

**613.03.02 Existing Curbs, Gutters, and Sidewalks.** Where the limits of the new work fall within reasonable distance to existing scoring lines or expansion joints, remove existing concrete to those scoring lines or expansion joints if directed. Where the limits of the new work do not fall within reasonable distance to existing scoring lines or expansion joints, saw cut the limits of the new work and remove existing concrete to the saw cut lines.

**613.03.03 Forms.** The depth of forms for curbs shall be equal to the full depth of the curb. The depth of outside forms for concrete gutters shall be equal to the full thickness of the gutter. Timber forms shall be surfaced on the side placed next to the concrete, have a true smooth upper edge, and be not less than 38 mm (1 1/2 in.) thick. Do not use warped forms or forms not having a smooth, straight upper edge.

Use benders or thin plank forms, rigidly placed, on curves, grade changes, or for curb returns. Do not use steel forms on radii less than 60 m (200 ft).

Make back forms for curb returns of 12.5 mm (1/2 in.) benders, for the full height of the curb, cleated together. Carefully set forms to the alignment, grade, and dimensions required. Hold forms rigidly in place by the use of pairs of iron stakes placed at intervals not to exceed 1.2 m (4 ft). For metal forms, do not space iron stakes more than 1.8 m (6 ft) apart. Use clamps, spreaders, and braces where required to insure rigidity in the forms.

Do not remove forms until concrete has set sufficiently to prevent distorting or cracking.

Clean forms thoroughly each time they are used and coat with a light oil as often as necessary to prevent the concrete from adhering to them.

**613.03.04 Curb and Gutter Joints.** Construct expansion joints 12.5 mm (1/2 in.) wide in curbs and gutters at 27 m (90 ft) intervals, at each side of structures, and at the ends of all curb returns.

Do not install expansion joints within 6 m (20 ft) of an island nose.

Fill expansion joints with joint filler strips 12.5 mm (1/2 in.) thick conforming to Subsection 707.03.01. Shape expansion joint filler to the cross section of the curb and gutter.

Construct expansion joints at right angles to the line of the curb and gutter.

Score weakened plane joints at right angles to the line of curb and gutter to a depth of 12.5 mm (1/2 in.) at 3 m (10 ft) spacing with a jointer tool having a radius of 12.5 mm (1/2 in.).

**613.03.05 Sidewalk Expansion Joints.** Construct transverse expansion joints 12.5 mm (1/2 in.) wide at all sidewalk returns and opposite expansion joints in adjacent curb.

Where curb is not adjacent to sidewalk, construct expansion joints at intervals of 9 m (30 ft).

Fill expansion joints with joint filler strips 12.5 mm (1/2 in.) thick conforming to Section 707.

Place the joint filler with the top edge 6 mm (1/4 in.) below the surface and hold in place by means of steel pins driven into the subgrade and spaced sufficiently close to prevent warping of the filler during floating. Upon completion of floating, remove the pins.

Upon completion of finishing operations, edge the joint with an edging tool having a radius of 12.5 mm (1/2 in.).

**613.03.06 Curb and Gutter Construction.** Construct curbs at driveways and ramps as shown on the plans.

Curbs may be constructed by the use of an approved curb forming machine.

Where plantmixed surfacing is to be placed around or adjacent to manholes, drop inlets or catch basins in gutters, local depressions, or driveway areas, do not construct such structures to final grade until after the curbs and gutters have been constructed for an acceptable distance on each side of the structure.

Where Portland cement concrete pavement is to be placed around or adjacent to manholes, drop inlets, or catch basins in gutters, local depressions, or driveway areas, do not construct such structures to final grade until after the concrete pavement has been constructed.

Anchor concrete curbs over new or existing pavements with epoxy adhesive conforming to Subsection 613.02.01. Cure the new pavement for a minimum of 2 weeks before bonding the curb thereon. Thoroughly clean the surface of all loose material, dirt, and dust. Apply the mixed adhesive to the dry and cleaned surface in a strip extending full width and length of the curb.

Fill the forms to the top. Place concrete so that there will be no rock pockets.

Concrete may be compacted by means of approved mechanical vibrators.

Immediately after removing the front curb forms, trowel the face of the curb smooth to a depth of not less than 50 mm (2 in.) below the flow line or to the flow line of integral curb and gutter, and then finish with a steel trowel.

Finish the top and round the front and back edges as shown on the plans.

After troweling, give the face of the curb a fine brush finish with brush strokes parallel to the line of the curb.

The top and face of the finished curb shall be true and straight, and the top surface of curbs and gutters shall be of uniform width, free from humps, sags, or other irregularities. When a straightedge 3 m (10 ft) long is laid on the top or face of the curb or on the surface of gutters, the surface shall not vary more than 3 mm (1/8 in.) from the edge of the straightedge, except at grade changes or curves.

Cure the exposed surfaces according to Subsection 501.03.08.

**613.03.07 Sidewalk and Driveway Construction.** Place reinforcing steel, if shown on the plans, according to the construction requirements of Section 505.

Finish sidewalks and driveways to a smooth and uniform texture by troweling and by floating with wooden floats, and, if directed, by cross-brooming or burlap-finishing.

Score weakened plane joints to a depth of 12.5 mm (1/2 in.) and at right angles to the line of work with a jointer tool having a radius of 12.5 mm (1/2 in.).

Score weakened plane joints so as to form squares or other shapes to match other such markings on similar existing structures in the vicinity.

Satisfactorily finish the surface finish of ramps rougher than the adjacent sidewalk.

The finished sidewalk and driveway surfaces shall be free from humps, sags, or other irregularities. When a 3 m (10 ft) straightedge is placed on the sidewalk or driveway, the surface shall not vary more than 3 mm (1/8 in.) from the edge of the straightedge, except at grade changes.

The finished surfaces shall be free from blemishes.

Cure the concrete surface according to Subsection 501.03.08.

**613.03.08 Detectable Warnings.** Install detectable warnings as shown in the plans and according to the manufacturer's recommendations.

Where detectable warnings are installed in existing ramps, saw cut and remove existing concrete sidewalk to accommodate installation. Dispose of removed material according to Subsection 107.14. Regrade and compact base material.

The elevation of the detectable warnings shall be flush with the adjacent surface.

METHOD OF MEASUREMENT

**613.04.01 Measurement.** Curb, glue down curb, gutter, and combination curb and gutter will be measured by the linear meter (linear foot) along the base of the curb face or along the flow line of the gutter. Such measurement will be continuous along such line extended across driveway and ramp openings.

Sidewalk and driveways will be measured by the square meter (square yard).

Ramps will be measured by the square meter (square yard) for those ramps constructed in existing sidewalk and curb and gutter areas where new sidewalks and curbs and gutters are not required to be constructed. Ramps constructed in new sidewalk and curb and gutter areas shall be included in the new sidewalk and new curb and gutter bid items.

The back curb constructed at the back of any curb ramps will be measured by the square meter (square yard) as the ramp or sidewalk bid items.

In the case of integral curb and walk, the width of the walk shall extend to the back face of the curb. In the case of steps, the area measured will be the summation of the areas of the treads, computed by multiplying the width of the tread by the length of the tread out to out of integral wall, if any.

Driveways for multi-family, commercial, and industrial driveways will be measured by the square meter (square yard), including the area for adjacent curbs and valley gutters as hereinafter specified. The curb constructed at the sidewalk or ramp edge of multi-family, commercial, or industrial driveways, which is integral with the driveway slab, will be measured by the square meter (square yard) to the back face of curb as the driveway bid item. Also the valley gutter constructed across the multi-family, commercial, or industrial driveways will be measured by the square meter (square yard) as the driveway bid item.

Detectable warnings will be measured by the square meter (square yard). Removal of sidewalk in existing ramps will be measured and paid for according to Section 202.

BASIS OF PAYMENT

**613.05.01 Payment.** The accepted quantities, measured as provided above, will be paid for at the contract price per unit of measurement for the pay items listed below that are shown in the proposal. Payment will be full compensation for the work prescribed in this Section.

All excavation and base course work will be paid for as provided in the respective Sections of the specifications; however, when bid items are not provided for excavation or base course work, such work will be considered subsidiary to the pay item contained herein.

Payment will be made under:

| Pay Item | Pay Unit |
|---|---|
| (class) Concrete Curb (type) | Linear Meter (Linear Foot) |
| (class) Concrete Gutter (type) | Linear Meter (Linear Foot) |
| (class) Concrete Curb and Gutter (type) | Linear Meter (Linear Foot) |
| (class) Concrete Sidewalk (depth) | Square Meter (Square Yard) |
| (class) Concrete Driveway (depth) | Square Meter (Square Yard) |
| (class) Concrete Driveway (depth) (Reinforced) | Square Meter (Square Yard) |
| (class) Concrete Ramp (depth) | Square Meter (Square Yard) |
| (class) Concrete Glue Down Curb (type) | Linear Meter (Linear Foot) |
| Detectable Warnings | Square Meter (Square Yard) |

# SECTION 614

## PAINTING

DESCRIPTION

**614.01.01 General.** This work consists of painting of steel, timber, or concrete structures.

MATERIALS

**614.02.01 General.** Raw materials shall conform to ASTM and federal specifications.

Federal specifications are specified to designate the type of material and standard of quality. Manufacturer's standard, first grade materials meeting or exceeding these requirements may be used if approved. Do not use materials not bearing manufacturer's identification as a standard, first grade product, of his regular line.

Proprietary materials when specified by the manufacturer's trade name designate the standard of quality and type of material required. When the quality or type of material required is not specified, apply for direction as to selection of materials and receive approval before proceeding. Use the best quality of such materials as directed.

Submit materials lists for approval. Deliver all materials to the site in original containers, seals unbroken, stored properly and separately.

Submit a one liter (quart) sample from each batch or lot at least 20 working days before the start of painting. The samples will be tested by infrared techniques. The infrared finger prints must match the spectrum produced by the standard paint sample on file with the Department's Materials Division. Do not use paint found not to parallel the standard. Do not commence work until samples have been tested and approved. Immediately remove materials that are not approved from the jobsite.

If approved, submission of samples may be waived for projects where the total of all coats will be less than 38 L (10 gal).

Do not use materials that exceed the manufacturer's initial expiration date.

**614.02.02 Number and Kinds of Coats.** The number and kinds of coats of paint shall be as set forth in Section 714.

For steel bridge girders, the type of complete coating system shall be as set forth in Subsection 714.03.01. The color of the finish coat shall be specified in the Special Provisions.

CONSTRUCTION

**614.03.01 Weather Conditions.** Apply paint only on thoroughly dry surfaces. Do not paint when the atmospheric temperature is at or below 4 °C (40 °F), or when freshly painted surfaces may become damaged by rain, wind, dust, or condensation, or when it can be anticipated that the atmospheric temperature will drop below 4 °C (40 °F) during the drying period. Replace fresh paint damaged by the elements.

The temperature of steel surfaces shall be above 4 °C (40 °F), but shall not be so hot as to cause blistering of the paint. The relative humidity shall be less than 85% or the combination of temperature and humidity conditions shall be such that moisture will not condense on the steel surfaces being painted. The Engineer may perform the following test to determine if such conditions exist. Using a damp cloth, apply a clearly defined, thin film of water to a small area. If the film evaporates within 15 minutes, the surface may be painted.

Suitable enclosures may be provided, if approved in writing, to permit painting during inclement weather. Make provisions to control atmospheric conditions artificially inside the enclosures within the limits suitable for painting throughout the painting operation.

**614.03.02 Application.** (a) General Requirements. Use painters and finishers of established status and reputation for executing their work by the very best methods for each kind or type.

Strictly adhere to these specifications and the recommendations of the manufacturer whose materials are used.

Use such skills, equipment, materials, and give thorough attention to details as will provide thoroughly workmanlike and satisfactory results throughout.

Mix coatings in original containers using mechanical mixers. Follow manufacturer's written recommendations for mixing time, method, and straining, and for continuous agitation when using suspended metallic particles. Do not mix previously mixed materials with new material. Use care to ensure no solid material is left at the bottom of containers and coatings are thoroughly mixed to achieve a uniform mixture with all particles wetted. Do not apply the material beyond recommended pot life.

Paint specified or formulated shall be ready for application. Thin paint only if approved.

Protect all parts of the structure being painted against disfigurement by spatters, splashes, and smudges of paint or paint materials. Protect passing vehicles or persons from the operations by use of canvas shields or other protective means as necessary.

Do not paint stay-in-place metal forms for bridge decks.

Paint in a neat and workmanlike manner that does not produce excessive paint build-ups, runs, sags, thin areas in the paint coat, or skips and holidays. Apply paint by brush, spray, roller, or any combination thereof as necessary for the paint being applied.

Paint surfaces that are inaccessible for painting by regular means, using sheepskin daubers, bottle brushes, or by other acceptable methods.

Remove and refinish or repaint any work which shows carelessness, lack of skill and execution, or which is defective due to any other cause as directed. Remove paint stains which result in an unsightly appearance.

Store and mix paint in a secure, contained location to eliminate the potential for contamination or damage to public or private property.

(b) Qualification Requirements for Painting of Structural Steel used for Bridge Members. Painters and sandblasters, in both shop and field, shall demonstrate their ability to prepare the surface and to apply the specified coatings according to these specifications. Variations or simplifications of this qualification procedure may be set forth by the Engineer if it is appropriate for special coating work or the qualifying of shop personnel. The ability of the painter and/or sandblaster to apply specified coatings with the proper tools and equipment will be evaluated. Lack of proper tools and equipment shall be cause for disqualification.

The painter and/or sandblaster shall provide the following:

1. The source and gradation of the sandblast abrasive to be used.

2. The type and source of solvent to be used.

3. Manufacturer's information regarding the specified coating materials, including wet and dry-film thicknesses, product safety data, thinning recommendations, temperature requirements, profile recommendations, mixing and application procedure, and equipment required.

4. Coating materials properly mixed according to manufacturer's recommendations and specifications and ready for application.

5. All necessary equipment for the proper application of the specified coating.

6. A practice area outside the project limits to adjust and test equipment before performing the test.

7. Safety practices and equipment complying with the Steel Structures Painting Council (SSPC) Paint Application Guide No. 3 "A Guide to Safety in Paint Application."

8. Wet and dry-film thickness gages for testing the coating thickness during and after applications.

The painter and sandblaster shall apply the specified coating according to these specifications to prescribed test areas selected at the shop and field sites. The approved test area should be approximately 10 $m^2$ (100 $ft^2$). The painter and sandblaster shall perform the application using the proper technique and application equipment

consistent with the specified coating materials and consistent with the paint manufacturer's recommendations. Prepare the surface of the test area according to these specifications. Surface preparation shall be approved before the application of the paint. The painter shall apply the specified coating to a uniform dry-film thickness according to the specifications and the manufacturer's recommendations. The required drying time as prescribed by the manufacturer's recommendations shall elapse before taking the dry-film reading of the applied surface. Primer, intermediate, and finish coats shall be treated as separate applications, allowing the specified drying time before inspecting each completed coat.

The painter and/or sandblaster shall consult with the paint manufacturer's technical representative for answers to technical questions relating to the application of the specified coating materials. The Contractor and/or fabricator shall be thoroughly familiar with the specified coating materials and acceptance criteria and shall be aware of any possible difficulties in applying the coating to any specified surface.

Dry-film thickness readings will be taken on all areas of the test area including nuts and bolts. Inadequate surface preparation, improper profile, runs, sags, overspray, thin film thickness, excessive film thickness, uneven coating, non-uniform color, improper curing, holidays, or any other defect in the coating system shall be a cause for disqualifications.

Qualification may be withdrawn any time the performance of the painter, sandblaster, or their equipment is in question.

A sandblaster or painter who was qualified on a previous Department project within the last year may be accepted. The sandblaster or painter must requalify if any materials or equipment changes are made from the original qualification.

**614.03.03 Surface Preparation of Steel.** Unless otherwise approved, use the sandblasting method. Before surface preparation, round all edges of steel members to a radius of 1.5 mm (1/16 in.), whether composed of steel plates, structural shapes, or a combination of steel plates and structural shapes.

(a) Sandblasting. 1. Shop Preparation. Clean surfaces of all oil, grease, and dirt with clean petroleum solvents and then blast clean to a near-white finish according to SSPC-SP 10 and SSPC-VIS 1 photos.

Remove all fins, tears, slivers, and burred or sharp edges that are present on any steel member, or that appear during the blasting operation by grinding. Re-blast ground areas to give a 50 µm (2 mils) surface profile.

Scaling hammers may be used to remove heavy scale. Do not use heavier type chipping hammers.

Abrasives used for blast cleaning shall be either clean dry sand, steel shot, mineral grit or manufactured grit and shall have a gradation such that the abrasive will produce a uniform profile of 25 to 50 µm (1 to 2 mils). Gradation of abrasives shall also be such that the angularity of the surface profile meets the requirements of the paint manufacturer.

Remove all abrasive and paint residue with a commercial vacuum cleaner equipped with a brush-type cleaning tool, or by double blowing. Vacuum the top surfaces of all structural steel after double blowing. Keep the steel dust free and prime within 8 hours after cleaning.

Protect freshly coated surfaces from subsequent blast cleaning operations. Thoroughly wire brush blast damaged primer surfaces. If visible rust occurs, reblast to a near-white condition. Vacuum and reprime the wire brushed or blast cleaned surfaces.

Mask all areas where field welding is required, before shop painting.

Do not apply the prime coat to any prepared surfaces until the surface has been inspected and approved.

2. Field Preparation. Repair any damage to paint which occurs during shipping, handling, and erection. Power wash primed surfaces without intermediate or finish coats which are exposed to the elements to remove all road dirt and salt.

After erection work has been completed, remove all scale, dirt, grease, form oil, or other foreign matter with a clean petroleum solvent and blast clean any rust areas to a near white finish according to SSPC-SP 10 and SSPC-VIS 1 photos. Remove all abrasive and paint residue with a commercial vacuum cleaner equipped with a brush-type cleaning tool, or by double blowing. Vacuum the top surfaces of all structural steel after double blowing.

Thoroughly wire brush the coating surrounding the blasted area and re-prime the area using the same paint, and the same dry-film thickness specified for the prime coat. Allow the touch-up coat to dry at least 48 hours, or the time required by the manufacturer, before application of the intermediate coats.

After erection, clean all bolts according to "(c) Hand Cleaning" of this Subsection. Apply a prime coat to the bolted area before application of the intermediate and finish coats.

During blast cleaning operations, protect pedestrians and vehicles with a barrier system, which will protect against direct blasting of vehicles or pedestrians and prevent spreading of falling abrasive materials and debris on the traveled portions of the pavement.

(b) Steam Cleaning. Remove all dirt, grease, loose chalky paint, or other foreign material which has accumulated on the previously painted surfaces with an approved steam cleaning apparatus which shall precede all other phases of cleaning.

It is not intended that sound paint be removed by this process. Do not perform subsequent painting until the cleaned surfaces are thoroughly dry and in no case in less than 24 hours after cleaning.

Add a detergent soap consisting of 45% sodium metasilicate, 43% sodium sesquisilicate, 10% sodium tetraphosphate, and 2% naccanol to the feed water of the steam generator at the approximate rate of 1 part of detergent to 200 parts of water by mass.

Remove any residue which may accumulate on cleaned surfaces by flushing with fresh water.

(c) Hand Cleaning. Remove all dirt, loose rust, and mill scale, dead paint, and paint which is not firmly bonded to the metal surfaces by hand or powered wire brushes, hand scraping tools, or sandpaper.

Do not use pneumatic chipping hammers unless approved in writing.

Hand cleaning will be permitted as an alternative to sandblasting on all steel except bridge girders. Clean bridge girders according to "(a) Sandblasting" of this Subsection, supplemented by minor amounts of hand cleaning as accepted.

**614.03.04 Painting Structural Steel.** (a) General. Perform all painting in a neat and workmanlike manner as described in SSPC-PA 1, producing a uniform, even coating which is bonded to the underlying surface.

Surfaces to be painted shall be free from moisture, dust, grease, or any other deleterious material which would prevent the bond of the succeeding paint coats. In spot painting, remove any old paint which lifts after application of the first spot coat by scraping and repaint the area before application of the next coat.

Excessively thick coats of paint will not be permitted. Limit the thickness of each coat to that which will result in uniform drying throughout the paint film.

Paint coats shall be free of runs, sags, areas of excessive or deficient thickness, embedded deleterious materials and holidays.

Unless otherwise noted in the plans, apply prime, intermediate, and top coat to all required surfaces in the fabrication shop, except as necessary for bolting or welded field splices. Faying surfaces shall only be coated with the prime coat prior to field erection and bolting.

Do not apply the intermediate or finish coats until the required total film thickness of the undercoats of paint is obtained.

Paint all surfaces (inside and outside) of steel bridge girders. Need not paint metal surfaces embedded in concrete.

Unless otherwise shown in the plans, paint machine finished metal surfaces and surfaces of iron and steel castings which have been machine finished with a prime coat of paint.

Satisfactorily repair any damage to sound paint, on areas not designated for treatment, resulting from the painting operations.

Discard unused portions of mixed material that is beyond the recommended pot life at the end of each work day.

(b) Coating Requirements. Apply the paint with spray nozzles at pressures recommended by the manufacturer of the coating system. A minimum of 3 coats of paint shall be required (prime, intermediate, finish). The intermediate coat of paint shall be of such shade as to contrast with both the prime and finish coats.

For structural steel for bridge members, the dry-film thickness of the prime coat shall be between 64 to 152 µm (2.5 to 6 mils). The dry-film thickness of the intermediate coat shall be greater than 102 µm (4 mils). The dry-film thickness of the finish coat shall be greater than 50 µm (2 mils).

For other structural steel, the prime coat shall consist of a minimum dry-film thickness of 50 µm (2 mils). The intermediate coat shall consist of a minimum dry-film thickness of 38 µm (1.5 mils). The finish coat shall consist of a minimum dry-film thickness of 38 µm (1.5 mils). Total thickness of all coats shall not be less than 126 µm (5 mils).

The dry-film thickness will be determined by the use of a magnetic film thickness gage.

If the required film thickness cannot be obtained by one coat application without producing runs, bubbles or sags, apply the paint in 2 or more coats. Where paint coats produce “mud-cracking,” scrape back such coating to soundly bonded coating or bare steel and recoat the area to the required thickness.

(c) Shop Painting Operations. If the manufacturer of the coating system recommends a tie coat between the prime and intermediate coats, obtain and apply the tie coat according to the manufacturer’s recommendations.

Transfer or preserve erection and weight marks for field identification of members.

Prime coat on structural steel bridge members shall be tested with a solvent rub test and an adhesion test. Test locations will be determined by the Engineer.

Perform a Solvent Rub Test according to ASTM D4752 using the following frequency:

1. At three random locations on each completed girder segment.

2. At one location on one secondary component (splice plates, cross frames, etc.) for each lot of ten components for each type of component.

Primed surfaces shall demonstrate a resistance rating of 5 (no effect on surface; no zinc on cloth) before proceeding with application of the intermediate coat. Repair primed surfaces damaged during the rub testing.

Perform an Adhesion Test according to ASTM D4541 using the following frequency:

1. At four random locations on each completed girder segment.

2. At one location on one secondary component (splice plates, cross frames, etc.) for each lot of 10 components for each type of component.

The primer shall have an adhesion to steel of at least 4 MPa (600 psi).

If 2 or more locations of a girder segment tests fail adhesion requirements, the girder segment is rejected. If one of the girder segment tests fails, test an additional 3 locations. If any of the additional locations fail, the girder segment is rejected.

If the location of secondary component test fails adhesion requirements, test an additional 2 locations. If either of the additional locations fails, the lot represented by the test is rejected.

Repair rejected girders and components by blast cleaning and repainting. Repair test locations meeting adhesion requirements by applying primer at the specified dry-film thickness.

Thoroughly clean areas having deficient primer thickness with power washing equipment to remove all dirt. Wire brush, vacuum, and re-coat such areas.

Caulk open seams at contact surfaces of built-up members after the prime coat has been applied and accepted. Use non-sag polysulfide or polyurethane material conforming to FSS TT-S-230, Type II, or approved equal.

Satisfactorily correct any deficiencies in the prime coat, before the application of succeeding coats. Do not apply the intermediate and/or finish coats until the surface has been approved.

Do not load material for shipment for a period of 24 hours after the last shop applied coat has been applied and not until material is approved for release.

(d) Field Painting Operations. After erection, welding, and final bolt tensioning, clean all surfaces of unpainted structural steel, which will be exposed to air, according to “2. Field Preparation” of Subsection 614.03.03.

Furnish and erect approved scaffolding to permit inspection of the steel before and after painting. Use rubber rollers, or other approved protective devices, on scaffold fastenings. Do not use metal rollers or clamps and other type fastenings which will mar or damage freshly coated surfaces.

Do not apply the intermediate or finish coats until the surface has been approved. The requirements for mixing, thinning, and applying the prime coat, and the conditions under which the prime coat may be applied, shall also govern for field applied coats.

Apply the intermediate and finish coats to bolted or welded splice areas at the construction site after the steel erection work has been completed.

Protect pedestrian and vehicular traffic, as well as all portions of the structure which are not to be painted including superstructure, substructure, slope protection and highway appurtenances from splatter, splashes, and overspray. Before painting, submit a plan detailing the method of protection to be used for approval.

If satisfactory protection is not provided, the work will be suspended until corrections are made. Remove any abrasive material and debris deposited on the pavement, shoulders, slopes, or slope paving in the work area before reopening those areas to traffic.

**614.03.05 Painting Timber.** Clean and prepare the surface to be painted by removing dust or other foreign material by approved methods. On previously painted timber, remove all cracked or peeled paint, loose chalky paint, dirt, and other foreign matter by wire brushing, scraping, or other approved means. Do not apply paint if the moisture content of the timber is more than 20%.

Paint timber with 3 coats of paint.

If permitted in writing, the first coat of paint may be applied before erection.

After the first coat has dried and the timber is in place, fill all cracks, checks, nail holes, or other depressions with approved putty flush with the surface. Allow putty to dry before the second coat is applied.

Satisfactorily correct skips, holidays, thin areas, or other deficiencies in any coat of paint before applying the succeeding coat.

Remove any deleterious material from the surface of the paint coat being covered before any additional paint is applied.

BASIS OF PAYMENT

**614.05.01 Payment.** No direct payment will be made for the work prescribed in this Section. Compensation shall be considered as included in the contract unit prices bid for the particular items requiring painting.

# SECTION 616

## FENCING

### DESCRIPTION

**616.01.01 General.** This work consists of constructing fences, gates, or reconstructing fences.

This work also consists of installing temporary tortoise fence.

### MATERIALS

**616.02.01 General.** Materials shall conform to the following Sections:

| | |
|---|---|
| Portland Cement Concrete | Section 501 |
| Fence Materials | Section 724 |

(a) Temporary Tortoise Fence. Use T-section posts conforming to Subsection 724.03.02. Use plastic fence material 1.2 m (4 ft) high, manufactured by one of the companies listed in the QPL.

In lieu of plastic fence material, a steel hardware cloth may be used. The steel hardware cloth shall be commercial quality welded galvanized steel wire fabric, 1.2 m (4 ft) high, 25 mm (1 in.) by 50 mm (2 in.) mesh size with 1.5 mm (16 gage) minimum diameter wire.

### CONSTRUCTION

**616.03.01 General.** Remove and dispose of all trees, brush, and other obstructions which interfere with proper construction of fences according to Section 201, except that no direct payment will be made for such work.

When constructing chain-link fence, remove rocks and other surface irregularities that require moving in order to maintain a nearly smooth surface.

Conduct fence construction operations as to prevent the escape of livestock. Connect existing cross fences to the new fence. Place corner posts, with braces for every direction of strain, at the junction with existing fences. Properly fasten the wire in both fences to the posts. At bridges and cattle passes, and at culverts if shown on the plans, connect the new fence to the structure in such a manner as to permit the free passage of livestock through or under the structure.

Install permanent tortoise fencing on existing fence or on new fencing. Perform grading of existing ground as necessary. Install fence fabric as shown on the plans. Cover buried portion as shown with suitable material.

Install temporary tortoise fence T-section posts at 3 m (10 ft) maximum spacing and driven a minimum of 450 mm (18 in.) into the existing ground at the required locations. Perform grading of existing ground as necessary. Mount the fence fabric to the posts with approved hog rings, wire ties, or cable ties. Minimize impact to the surrounding area during installation.

Maintain the temporary tortoise fence and its ground contact during its use. Remove the temporary tortoise fence when it is no longer required.

Fasten barbed wire, farm fence, and chain-link fence fabric on the side of the posts opposite the highway centerline.

Backfill post holes for metal posts, that are drilled or dug, with Class A or AA concrete.

Securely fasten each strand of barbed wire to a braced post at each intermediate braced post assembly by wrapping twice around the post then securing to that part of the same wire stretched between posts. Cut off the remaining wire to present a neat and workmanlike appearance.

Do not splice galvanized pipe brace rail.

Tie the first line of barbed wire above wire mesh to the top wire of the wire mesh, midway between posts, with 2.8 mm (12 gage) galvanized steel wire or 4.0 mm (9 gage) aluminum hog rings.

For timber intermediate braced post assemblies, place the horizontal brace 150 mm (6 in.) below the tops of the brace posts and properly fit and connect to them by two 9.5 mm (3/8 in.) by 100 mm (4 in.) steel dowels. Extend the dowel pins 50 mm (2 in.) into each brace and brace post. Run two strands of 4.5 mm (8 gage) galvanized wire as a brace diagonally from 100 mm (4 in.) above ground line on each brace post to 100 mm (4 in.) below the top of the other brace post. Make an extra loop around each post at the point of attachment and firmly staple the wire to the post. Twist these brace wires until the assembly is rigid.

Construct corner post assemblies as indicated on the standard fence details. Construct end post assemblies of end posts and brace posts installed and braced as indicated for timber corner braces.

Timber line posts may be installed by tamping firmly in place in drilled or dug holes or by driving, provided the method of driving does not damage the posts or cause the posts to be deflected from line and plumb. Install all other timber posts in drilled or dug holes and tamp firmly in place. Install round timber posts in drilled or dug holes and place the butt end downward. Machine point timber line posts which are to be driven, at the plant before being treated. Point the small end of driven round timber posts.

Securely fasten each strand of barbed wire to a corner post, end post, or intermediate braced post assembly by wrapping twice around the post and securing to that part of the same wire stretched between the posts. Cut off the remaining wire to present a neat and workmanlike appearance.

Set staples to hold the wire securely, but do not bury in the post as to severely nick or bend the wire.

**616.03.02 Standard Fence.** Standard fencing shall be designated by types as follows: Metal posts—Type A; Wood posts—Type B; Combination metal and wood posts—Type C. The type of fence construction shall be as shown on the plans and indicated in the proposal.

Firmly set or drive posts into the ground and space as indicated.

Firmly brace each end, corner, and gate post and set in concrete when required. Brace posts as indicated on the plans.

Standard fencing will be designated not only by type, but also by a symbol indicating the fencing required. For metric unit contracts, Type A-881-3B will be used to designate a fence composed of metal posts, 8 horizontal wire, 810 mm woven wire (farm fencing) and 3 barbed wires; Type C-766-4B to designate a fence composed of a combination of metal and wood posts, 7 horizontal wire, 660 mm woven wire and 4 barbed wires, etc. The figures 881, etc., when they appear in the symbol, correspond to design numbers set forth in the standard plans.

For English unit contracts, Type A-832-3B will be used to designate a fence composed of metal posts, 32 inch woven wire (farm fencing) and 3 barbed wires; Type C-726-4B to designate a fence composed of a combination of metal and wood posts, 26 inch woven wire and 4 barbed wires, etc. The figures 832, etc., when they appear in the symbol, correspond to design numbers set forth in the standard plans.

Fencing designated with 3S or 4S in the description shall utilize smooth wire. The wire and fencing shall conform to the requirements for barbed wire fencing, except the wire shall not contain barbs.

In determining the post spacing, measurements will be made parallel to the slope of the natural ground. Place all posts in vertical position, except in unusual locations where directed to place the posts perpendicular to the slope of the ground. Measure all intervals center to center of adjacent posts.

Consider changes in line where the angle of deflection is 30 degrees or more as corners, and install corner posts. Consider changes in line where the angle deflection is more than 15 degrees and less than 30 degrees as alignment angles, and fasten adjacent posts to the angle posts by means of wire, or if such method is impracticable in the opinion of the Engineer, brace such posts as above specified for bracing gate, end, and corner posts.

At all grade deflections and alignment angles where stresses tend to pull the posts from the ground, snub or guy the fencing at the critical point by means of a double strand of 4.00 mm (9 gage) galvanized wire connected to each horizontal line of barbed wire or to the top and bottom of wire mesh fabric, and to a deadman weighing approximately 50 kg (100 lb), buried in the ground not less than 0.6 m (2 ft). Pull the fencing snug close to the ground before being snubbed or guyed.

Stretch barbed wire and farm fence fabric (woven wire) taut and securely fasten to each post by acceptable devices.

**616.03.03 Chain-Link Fence.** Consider changes in line where the angle of deflection is 30 degrees or more as corners and install corner posts.

Between posts, fasten chain-link fences to a bottom and a top tension wire.

Space line posts at not more than 3 m (10 ft) intervals, measured from center to center of posts. In determining the post spacing, make measurements parallel to the slope of the natural ground.

Place all posts in a vertical position, except in unusual locations where directed to place the posts perpendicular to the slope of the ground.

Set metal posts in Class A or AA Portland cement concrete footing crowned at the top to shed water.

Brace end, corner, and gate posts with galvanized braces used as compression members and galvanized steel truss rods with truss tighteners used as tension members. Brace and truss line posts, at intervals of 150 m (500 ft), in both directions as shown on the plans.

Stretch the fabric taut and securely fasten to the posts. Between posts, fasten the top edge of the fabric to the top tension cable and fasten the lower edge to the bottom tension wire. Stretch tension cable and wire tight with truss tightener. Install the bottom tension wire on a straight grade between posts by excavating the high points of the ground and do not fill depressions.

Fasten the fabric to the end, corner, gate posts, and intermediate braced posts with 6 mm (1/4 in.) by 19 mm (3/4 in.) steel stretcher bars. Place 3 mm (1/8 in.) by 19 mm (3/4 in.) steel stretcher bar bands at 0.3 m (1 ft) intervals. Fasten fabric to line posts, tension cable, and tension wires with tie wires or metal bands. Space tie wires or metal bands on line posts at intervals of approximately 350 mm (14 in.) and on tension cables and tension wires approximately 450 mm (18 in.).

Fit all posts with tops designed so as to fit securely over the posts, and carry the top tension cable. The top of the C-section posts may be open-slotted in such a manner as to securely hold the top tension cable in position without vertical movement. Such slotting shall allow removal and replacement of a post without disturbing the top tension cable. Fit tubular posts with watertight tops.

Use either pipe or C-section posts. However, use the same post type for all chain-link fence. C-section line posts, corner, or end posts may be either Type II Terminal posts or NPS 2, 60.3 mm outside diameter (2.375 in. outside diameter), galvanized pipe weighing not less than 5.41 kg/m (3.63 lb/ft).

**616.03.04 Reconstruct Fence.** Carefully erect reconstructed fences using salvaged materials, and similarly in type to the original construction.

Furnish any new materials necessary to rebuild the fence of the same kind as those in the original fence. The resulting reconstructed fence shall be equal to or better than before removed. The Engineer may furnish new materials as deemed necessary. Use these new materials in lieu of salvage materials which they replaced.

**616.03.05 Gates.** The width of drive gates shall be as shown on the plans and as indicated in the proposal.

Drive gate height shall suit fencing but shall not be more than 1,800 mm (72 in.) nor less than 1,200 mm (48 in.). The wire mesh filler shall be rectangular or 50 mm (2 in.) diamond mesh for standard fencing and chain-link fence fabric for chain-link fencing.

Construct walk gates to the width shown on the plans and as indicated in the proposal, and of a height corresponding to the adjacent fence height.

Hang the gates by steel or malleable iron hinges so designed as to securely fasten to the gate posts and permit the gate to swing back against the fence.

Provide gates with a combination steel or malleable iron catch and locking-in attachment of approved design. Provide a center rest with catch where required.

Construct Missouri gates as shown on the Standard Plans.

## METHOD OF MEASUREMENT

**616.04.01 Measurement.** Fence will be measured by the linear meter (linear foot) along the top of the fence.

Temporary tortoise fence will be measured by the linear meter (linear foot) along the top of the fence.

Reconstructed fence will be measured by the linear meter (linear foot), including used gates.

Gates will be measured by the each. The size indicated for double gates is for the total width between posts.

Missouri gates will be measured by the each, regardless of width.

## BASIS OF PAYMENT

**616.05.01 Payment.** The accepted quantities, measured as provided above, will be paid for at the contract price per unit of measurement for the pay items listed below that are shown in the proposal. Payment will be full compensation for the work prescribed in this Section.

When an item for temporary tortoise fence does not appear in the proposal, such work shall be performed and payment therefore will be considered as subsidiary to other items of work. No additional compensation will be allowed.

Payment will be made under:

| Pay Item | Pay Unit |
|---|---|
| Type (designation) Fence | Linear Meter (Linear Foot) |
| Tortoise Fence | Linear Meter (Linear Foot) |
| (size) Chain Link Fence | Linear Meter (Linear Foot) |
| (size) Metal Drive Gate | Each |
| (size) Metal Drive Gate Double | Each |
| (size) Timber Drive Gate | Each |
| (size) Metal Walk Gate | Each |
| (size) Timber Walk Gate | Each |
| (size) Swing Gate | Each |
| (size) Swing Gate Double | Each |
| Reconstruct Fence | Linear Meter (Linear Foot) |
| Temporary Tortoise Fence | Linear Meter (Linear Foot) |
| Missouri Gate | Each |

# SECTION 617

## CATTLE GUARDS

### DESCRIPTION

**617.01.01 General.** This work consists of furnishing and constructing cattle guards and cattle guard wings.

Alternate designs of precast cattle guards may be submitted for approval. Designs approved by the Department's Headquarters Structural Design Division may be substituted for the designs indicated.

### MATERIALS

**617.02.01 General.** Materials shall conform to the following Sections and Subsection:

| | |
|---|---|
| Portland Cement Concrete | Section 501 |
| Reinforcing Steel | Section 505 |
| Steel Structures | Section 506 |
| Painting | Section 614 |
| Paint | Section 714 |
| Hardware | Subsection 718.03.04 |

Portland cement concrete shall be Class A or Class AA, unless otherwise provided.

All hardware shall be galvanized steel.

All lumber and timber shall be Douglas Fir, No. 2 joist and plank or No. 1 structural posts and timbers. Any commercial grading rules that will provide material of an equal or greater stress values may be used.

### CONSTRUCTION

**617.03.01 Earthwork.** Structure excavation and backfill shall conform to Sections 206 and 207.

**617.03.02 General.** Construct cattle guards and cattle guard wings according to the details shown on the plans.

Precast cattle guards may be substituted for steel cattle guards. Steel cattle guards may not be substituted for precast cattle guards.

Concrete and metal reinforcement construction shall conform to Sections 502 and 505.

Weld steel member connections in conformance with Section 506.

Do not paint structural steel for cattle guards. Paint steel cattle guard wings according to Section 614.

**617.03.03 Timber Wings and Timber Foundations.** Give the wing posts, wheelguards, and foundation timbers a preservative treatment conforming to Section 718. Do not paint treated timber and lumber.

Paint all untreated lumber and timber according to Section 614.

Workmanship shall be first class throughout. Frame true and exact. Drive nails and spikes with just sufficient force to set the heads flush with the surface of the wood. Avoid deep hammer marks in wood surfaces.

Carefully handle treated timber without sudden dropping, breaking of the outer fibers, bruising, or penetrating the surface with tools.

Perform all cutting, framing, and boring of treated timbers before treatment insofar as is practicable.

Cover all cuts in treated timbers, and all abrasions, after being carefully trimmed, with an approved preservative. Treat all bolt holes bored after treatment, with an approved preservative.

Bore holes for machine bolts with a bit of the same diameter as the bolt. Bore holes for lag screws with a bit not larger than the body of the screw at the base of the thread.

Use a washer of the size and type specified under all bolt heads and nuts which would otherwise come in contact with wood.

Countersink bolts whenever smooth faces are required.

METHOD OF MEASUREMENT

**617.04.01 Measurement.** Cattle guards will be measured by the each.

Cattle guard wings will be measured by the each where wings are installed on existing cattle guards.

BASIS OF PAYMENT

**617.05.01 Payment.** The accepted quantities, measured as provided above, will be paid for at the contract price per unit of measurement for the pay items listed below that are shown in the proposal. The cost of cattle guard wings shall be included in the contract unit price for cattle guards, however, where wings alone are required, they will be paid for at the contract unit price for cattle guard wings. Payment will be full compensation for the work prescribed in this Section.

Payment will be made under:

| Pay Item | Pay Unit |
|---|---|
| (size) Steel Cattle Guard | Each |
| (size) Precast Cattle Guard | Each |
| Cattle Guard Wings | Each |

# SECTION 618

## GUARDRAIL

DESCRIPTION

**618.01.01 General.** This work consists of constructing guardrail systems, furnishing and installing guardrail terminals, and reconstructing guardrail systems.

MATERIALS

**618.02.01 General.** Material shall conform to the following Sections:

| | |
|---|---|
| Portland Cement Concrete | Section 501 |
| Reinforcing Steel | Section 505 |
| Guardrail Materials | Section 720 |

Use wood or metal posts. Use the same type of post, where there are optional post types, for the entire project.

Give wood posts and blocks a preservative treatment by pressure processes after fabrication according to Section 718.

Other approved products for guardrail offset blocks may be used in lieu of wood blocks. The optional products approved for use as guardrail offset blocks are available from the manufacturers listed in the QPL.

Rail members having a radius of curvature of 46 m (150 ft) or less shall be fabricated with the required radius. Field bending will not be allowed. Stencil the radius of curvature on the back of each section in numerals 60 mm (2.5 in.) in height.

(a) Guardrail Terminals. Flared guardrail terminals shall be the type for installations which flare to 1.2 m (4 ft) away from the shy line parallel to the travel lanes. Tangential guardrail terminals shall be the type for installations parallel to the travel lanes.

Manufacturers of the appropriate guardrail terminals are listed in the QPL.

Select a product for flared guardrail terminals and install that same product at all flared guardrail terminal locations. Select a product for tangential guardrail terminals and install that same product for all tangential guardrail terminal locations.

Submit the manufacturer's shop drawings, foundation details, installation recommendations, and any other pertinent information for the guardrail terminals. Receive approval for the exact model of guardrail terminal proposed, prior to installation.

Furnish and install the units with all parts and materials necessary for them to perform as designed.

(b) Trailing End Anchors. The 19 mm (3/4 in.) cable and fittings shall conform to Subsection 720.03.03.

Use cable clips or a swaged fitting and clevis to attach the cable to the anchor rod. Cable clips shall be commercial quality drop forged galvanized steel.

Machine the swaged fitting from hot-rolled bars conforming to AISI C1035, and anneal suitably for cold swaging. Galvanize the swage fitting before swaging. Drill a lock pin hole to accommodate a 6 mm (1/4 in.), plated, spring steel pin through the head of the swage fitting to retain the stud in proper position. Stamp the manufacturer's identifying mark on the body of the swage fitting.

The 25 mm (1 in.) diameter threaded stud shall conform to ASTM A449 after galvanizing. Before galvanizing, mill a 10 mm (3/8 in.) slot for the locking pin in the stud end.

The swaged fittings, stud and nut assembly shall develop a minimum breaking strength of 190 kN (21.4 tons).

The clevises shall be drop forged galvanized steel and shall develop a minimum breaking strength of 190 kN (21.4 tons).

Fabricate the anchor rods from steel conforming to ASTM A36, ASTM A572, or ASTM A576, Grades 1018, 1019, 1021 or 1026. Hot forge or form the eyes with full penetration welds. After fabrication, thermally stress relieve anchor rods with eyes that have been formed with any part of the eye below 871 °C (1,600 °F) during the forming operation or with eyes that have been closed by welding before galvanizing. The anchor rod, after galvanizing shall develop a minimum strength of 220 kN (24.7 tons).

## CONSTRUCTION

**618.03.01 General.** Drive wood posts, with or without pilot holes, or place in drilled holes. Backfill any space around the wood posts in layers with approved material. Thoroughly ram backfill with an iron tamping tool in such a manner as not to displace the bottom of posts from correct alignment.

Drive steel posts. If ground conditions are such that pilot holes are necessary to prevent damage to posts during driving, fill any space around steel posts after driving with sand or other approved material.

Set posts plumb, except on superelevated curves set perpendicular to the roadbed. Front faces of posts shall form a straight line, except on curves where they shall be a uniform distance from the centerline of the roadway.

Furnish guardrail beam elements in 3.810 m (12.5 ft) or 7.620 m (25 ft) lengths.

After erection, the rail shall be true to line and grade and shall have the proper tension in the rail plates. Do not disturb posts during the erection of the rail. If necessary, temporarily brace posts to prevent displacement.

Thoroughly wire brush and remove all loose and cracked coating from galvanized surfaces that are abraded or damaged. Paint the cleaned abraded or damaged areas with 2 coats of paint having a high zinc dust content conforming to MIL-P-21035.

Clean all soiled exposed surfaces of the metal guardrail.

(a) Guardrail Terminals. Excavate any material encountered for the construction of the posts for guardrail terminals according to Section 206.

Set and backfill posts for the guardrail terminals in the same manner as for the guardrail posts.

Install guardrail terminals according to the plans and the manufacturer's recommendations.

(b) Trailing End Anchors. Drill or dig holes for the concrete anchor blocks.

Furnish and place reinforcing steel for the anchor blocks according to Section 505.

Construct concrete for the anchor blocks according to Section 502. Place concrete against undisturbed material of the excavated holes. Form the top 300 mm (12 in.) of the holes, if required.

After installation and before backfilling, coat the portion of the anchor rod to be buried in earth with a minimum 0.5 mm (20 mils) thickness of coal tar enamel conforming to AWWA Standard C203 or a coal tar epoxy conforming to Steel Structures Painting Council Specification No. 16, Coal-Tar Epoxy-Polymide Black Paint, or Corps of Engineers Specification, Formula C-200a, Coal-Tar Epoxy Paint.

Tighten anchor cables after the concrete anchor has cured for at least 5 days.

**618.03.02 Reconstruct Guardrail.** Carefully reconstruct guardrail to bring compliance with the Standard Plans. Furnish any new materials necessary to reconstruct the guardrail. The Department may furnish new materials to be used in lieu of salvaged materials.

## METHOD OF MEASUREMENT

**618.04.01 Measurement.** New or reconstructed guardrail will be measured by the linear meter (linear foot) measured along the front face of the rail between centers of posts.

Guardrail terminals, trailing end anchors, buried end anchors, anchor terminals, guardrail-bridge rail connections, or guardrail-barrier rail connections, will be measured by the each.

Guardrail posts and guardrail blocks will be measured by the each only when they are listed as separate items in the proposal. Guardrail posts and guardrail blocks will only be measured for payment at designated locations as shown on the plans and shall otherwise be considered as included in other items of work.

The additional guardrail beam elements required to construct double beam rail (nested beams) will not be measured or paid for directly.

Guardrail quantities shown on the plans are approximate. During construction the need for guardrail will be reviewed and a revised amount of guardrail required will be provided. Furnish only guardrail materials required by the Engineer's revised list.

## BASIS OF PAYMENT

**618.05.01 Payment.** The accepted quantities, measured as provided above, will be paid for at the contract price per unit of measurement for the pay items listed below that are shown in the proposal. Payment will be full compensation for the work prescribed in this Section.

Payment will be made under:

| Pay Item | Pay Unit |
|---|---|
| Galvanized Guardrail | Linear Meter (Linear Foot) |
| Galvanized Guardrail (Triple Corrugation) | Linear Meter (Linear Foot) |
| Reconstruct Guardrail | Linear Meter (Linear Foot) |
| Guardrail-Bridge Rail Connection (Triple Corrugation) | Each |
| Guardrail-Barrier Rail Connection (Triple Corrugation) | Each |
| Guardrail Terminal (Flared) | Each |
| Guardrail Terminal (Tangential) | Each |
| Trailing End Anchor | Each |
| Buried End Anchor | Each |
| Anchor Terminal | Each |
| Guardrail Post | Each |
| Guardrail Block | Each |

# SECTION 619

## OBJECT MARKERS AND GUIDE POSTS

DESCRIPTION

**619.01.01 General.** This work consists of furnishing and installing object markers and guide posts.

MATERIALS

**619.02.01 General.** Material shall conform to the following Section:

Object Markers and Guide Posts ..... Section 721

Flexible Type 2 Object Markers capable of rebounding after impact may be substituted for the metal Type 2 Object Markers indicated in the plans. Use flexible Type 2 Object Markers listed in the QPL.

When flexible guide posts are specified for use, use flexible guide posts listed in the QPL.

The color of flexible guide posts shall be white and the reflective sheeting shall be as indicated on the plans. The date of manufacture shall be permanently stamped on flexible guide posts.

CONSTRUCTION

**619.03.01 General.** Assemble, fasten, set, and align target members and reflectors appropriate to the color involved. Tighten all fastenings.

Install flexible guide posts according to the manufacturer's recommendations and as specified.

Place object markers at approved locations.

Install Flexible Type 2 Object Markers according to the manufacturer's recommendation and as specified.

Place guide posts and object markers when ordered for the protection of the public traffic. Replace guide posts and object markers which may be subsequently damaged by public traffic. Replacement guide posts and object markers will also be measured and paid for at the contract unit bid prices.

METHOD OF MEASUREMENT

**619.04.01 Measurement.** Object markers and guide posts will be measured by the each.

BASIS OF PAYMENT

**619.05.01 Payment.** The accepted quantities, measured as provided above, will be paid for at the contract price per unit of measurement for the pay items listed below that are shown in the proposal. Payment will be full compensation for the work prescribed in this Section.

Guide posts will be paid for on an each basis and each type (rigid or flexible), as specified in the proposal, will be considered separately. Note that the metal guide posts are classified as the rigid type of guide posts.

Payment will be made under:

| Pay Item | Pay Unit |
|---|---|
| Guide Posts (type) | Each |
| Object Markers (type) | Each |

# SECTION 621

## MONUMENTS

DESCRIPTION

**621.01.01 General.** This work consists of perpetuating survey monuments.

MATERIALS

**621.02.01 General.** Materials shall conform to the following Section and Subsection:

Portland Cement Concrete ..... Section 501
Bar Steel Reinforcement ..... Subsection 713.03.01

Concrete shall be Class A or Class AA Portland cement concrete.

The NPS 6 [168.3 mm (6.625 in.) outside diameter] galvanized steel pipe riser for survey monuments shall conform to ASTM A53, Type S, Grade B, Schedule 40.

The NPS 5 [141.3 mm (5.563 in.) outside diameter] steel pipe for the cover for survey monuments shall conform to ASTM A53, Type S, Grade B, black finish, 3.96 mm (0.156 in.) minimum wall thickness.

The welded steel cover for survey monuments shall conform to ASTM A36. Welding shall conform to Section 506.

The cast iron cover and ring for survey monuments shall conform to Subsection 712.03.02.

The bronze disks for survey monuments shall be commercial quality survey monuments. Provide bronze disks meeting the requirements of the governmental agency having jurisdiction thereof.

CONSTRUCTION

**621.03.01 Installation.** Concrete construction shall conform to Section 502.

Perpetuate survey monuments at existing monument location.

Excavate a hole for the survey monument to the required depth. Place concrete for base. Install the bronze disk in the required position for the survey monument after the concrete has set sufficiently. Construct risers and covers as shown on the plans.

Label the survey monument covers with the word “Survey.” Use letter heights of at least 25 mm (1 in.).

Perpetuate the monuments according to Nevada Revised Statutes Chapter 329 & 625, by a Licensed Nevada Professional Land Surveyor, and tie to 2 existing NDOT construction control monuments utilizing NDOT’s Special Instruction for Survey or Mapping Consultant’s Manual, which is available from the NDOT Location Division. Public Land Survey Corners are to be set in a survey well and referenced by 4 tie monuments set outside the construction zone. Send a copy of the recorded Corner Record for each monument with a written report by the land surveyor identifying the character, location, description, and ties of the new monument to the Chief Land Surveyor, Headquarters Building, 1263 S. Stewart Street, Carson City, Nevada 89712.

All found stamped or tagged survey monuments and public land survey corners will be listed in contract plans. Perpetuate all such monuments if they will be destroyed by construction activities.

Notify the Engineer of any other survey monuments discovered during construction, which are not listed in the contract plans, which may be disturbed by construction activities. Perpetuate any such discovered survey monuments if directed.

METHOD OF MEASUREMENT

**621.04.01 Measurement.** The perpetuating of survey monuments will be measured by the each.

BASIS OF PAYMENT

**621.05.01 Payment.** The accepted quantities, measured as provided above, will be paid for at the contract price per unit of measurement for the pay item listed below that is shown in the proposal. Payment will be full compensation for the work prescribed in this Section.

When a bid item is not provided for perpetuating survey monuments, and if directed to perpetuate any discovered survey monuments, the perpetuation of the survey monuments will be paid for as extra work according to Subsection 104.03.

Payment will be made under:

| Pay Item | Pay Unit |
|---|---|
| Perpetuate Survey Monument | Each |

# SECTION 623

## SIGNALS, LIGHTING, AND INTELLIGENT TRAFFIC SYSTEMS

DESCRIPTION

**623.01.01 General.** This work consists of furnishing and installing, modifying or removing traffic signals, traffic signal master control assemblies, controller cabinets, vehicle detection systems, pedestrian push buttons, interconnection facilities, ramp metering systems, flashing beacon systems, highway lighting systems, high mast lighting systems and high mast raising and lowering devices, sign illumination systems, traffic count stations, communication conduit, traffic monitoring stations, electrical equipment in structures, falsework lighting, partial installations for future systems, or combinations thereof.

This work also consists of furnishing and installing fiber optic cable including distribution equipment, splicing, and jumper cables.

This work also consists of furnishing and installing emergency vehicle optical detector (EVOD) systems at signalized intersections on signal standards and in control cabinets.

The locations of traffic signal control equipment, power services, lighting system standards and masts, illuminated sign structures, conduit runs, and all other appurtenances shown on the plans are approximate and the exact locations will be established in the field. Determine the exact location of all utilities, aerial and buried, that may interfere with equipment and systems installation. See Subsections 105.07 and 107.17.

All systems and system components must pass functional tests and be completely operational before final acceptance.

Where an existing system is to be modified, reuse the existing material in the revised system, or remove, salvage, and stockpile or abandon as shown on the plans, as specified in the Special Provisions or as directed. Unless otherwise specified, haul and stockpile salvaged materials not incorporated into the new system to an approved site designated by the owner or as designated. Such material shall remain the sole property of the owner.

**623.01.02 Abbreviations and Definitions.** Definitions of words and phrases pertaining to traffic control signal systems and related type work shall be as defined in the standards of NEMA (TS 1 and TS 2), applicable ITE documents, the MUTCD, this Subsection, and Subsections 101.02 and 101.03.

Beacon. A flashing signal indication used for hazard identification, school crossing, intersection control, or advance warning.

Electrolier. The complete assembly of lighting standard, luminaire, ballast and lamp.

ETL. Electronic Testing Laboratories.

FAST. Freeway and Arterial System of Transportation.

High Mast Standard. The pole designed specially to support the High Mast Head Frame Assembly.

High Mast Head Frame Assembly. The complete ring assembly that supports the luminaires, guide mechanism, cable sheaves, cable and includes the internally mounted lowering wench.

ICEA. Insulated Cable Engineers Association.

ISO. International Standards Organization.

ITS. Intelligent Transportation Systems. Intelligent Transportation Systems (ITS) represents the next step in the evolution of the State's entire transportation system. It involves the latest in computers, electronics, communications and safety systems. These advancements can be applied to our transportation infrastructure of highways, streets and bridges, to integrate with a growing number of vehicles, including cars, buses, trucks and trains.

Lighting Standard. The pole and mast arm which support the luminaire all of which make up the electrolier.

LVACTS. Las Vegas Area Computer Traffic System.

Maintaining Agency. Public entity, such as a city or county, responsible for the electrical energy costs and maintenance of the approved and accepted signal, lighting, and intelligent traffic system.

RUS. Rural Utilities Service (Past REA).

Video Detector. A detector that detects vehicles in multiple lanes utilizing multiple user definable detection zones through interactive graphics by placing virtual lines and/or boxes in an image display on a video monitor.

**623.01.03 Regulations, Codes, and Jurisdictional Policies.** All electrical equipment shall conform to the standards of the National Electrical Manufacturers Association (NEMA), Insulated Cable Engineers Association (ICEA), Electronic Industries Alliance (EIA), and be listed by the Underwriters Laboratories, Inc. (UL), wherever applicable. In addition to the requirements of the plans, these specifications, and the Special Provisions, all materials and workmanship shall conform to the National Electric Code (NEC), American Society for Testing and Materials (ASTM), American National Standards Institute (ANSI), International Municipal Signal Association (IMSA), Illumination Engineering Society (IES), Rural Utilities Service (RUS), Institute of Electronic and Electrical Engineers (IEEE), Electric Utility Service Equipment Requirements Committee (EUSERC), National Transportation Communications for ITS Protocol (NTCIP), and any local ordinances or maintaining agency requirements which may apply.

In addition to the above requirement, materials, equipment, and installation/construction procedures must meet the specifications and standards of the maintaining agency. Where specific products or materials are designated for specific agencies, only those items will be allowed for those agencies.

**623.01.04 Submittals, Equipment List and Drawings.** Unless otherwise permitted in writing, within 15 days following approval of the contract, submit for approval, a list of all equipment and materials proposed for installation. Provide such list complete with name of manufacturer, size, and identifying number of each item. Supplement the list by such other data as may be required, including schematic wiring diagrams and scale drawings of cabinets showing location and spacing of shelves, terminal blocks and equipment, including dimensioning.

Submit 6 copies of the above data for review. Where electrical equipment is constructed as detailed on the plans or supplied from one of the providers as shown in the QPL, the submission of detailed drawings and diagrams will not be required.

Before ordering signal poles, field verify the pole locations, mast arm lengths, and the tenon locations.

Field weld all tenons after pole and mast arm delivery in accordance with the requirements of Subsection 623.02.11 and Section 506.

Provide wiring schematic diagrams for all cabinet circuitry. Furnish two reproducible film positives with mylar base and one hard copy thereof, of the cabinet schematic wiring diagram for each controller cabinet. In lieu of reproducible film positives, Micro Station DGN files delivered on a CD rom will be acceptable.

The diagrams shall show the location of the installation and shall list all equipment installed in each cabinet. In addition, for each signal installation, furnish an intersection sketch showing poles, detectors, field wire connection terminals and intersection phasing. Place the hard copy of the controller cabinet diagram and the intersection and phase diagram in a heavy duty plastic envelope with side opening, and attach to the inside of the door of each controller cabinet. The Engineer will forward the two reproducible film positives or Micro Station DGN files to the Department's Safety/Traffic Division.

Submit all schematic wiring diagrams of the controllers and auxiliary equipment, all cabinet diagrams, and all operation manuals at the time the controllers are delivered for testing or, as directed, previous to purchase. Identify, by name or number, parts and circuits shown on this diagram in detail.

For internally illuminated street name signs, provide shop drawings showing the message for each sign and include the size of letters, symbols and arrows as shown on the plans and as furnished.

**623.01.05 Warranties, Guarantees, and Instruction Sheets.** Deliver manufacturer's warranties and guarantees furnished for materials used in the work and instruction sheets and parts lists supplied with materials before acceptance of the project.

**623.01.06 Maintaining Existing and Temporary Electrical Systems.** Keep existing electrical systems (traffic signal, interconnect, ramp metering, highway and street lighting, flashing beacon, traffic monitoring, sign illumination and other facilities), or approved temporary replacements thereof, in satisfactory operation for the benefit of the traveling public during the progress of the work, except when shutdown is permitted to allow for alterations or final removal of the systems. Limit the traffic signal shutdowns to normal working hours, or as specified in the Special Provisions. For lighting system shutdowns, do not interfere with the regular lighting schedule, unless otherwise permitted. Give at least 2 working days notification before performing work on existing systems.

Notify the local traffic enforcement agency and the traffic signal maintenance agency and obtain written approval before any operational shutdown of a traffic signal or lighting system.

State or local forces will continue operation and maintenance of existing electrical facilities. The State or local authorities will furnish electrical energy for operation and will repair or replace facilities damaged by public traffic or by State or local forces.

Promptly repair or replace facilities damaged by operations according to these specifications. Immediately give notification if any existing interconnect, loop detector or lead-in conductor is damaged by operations, including that portion leading to the termination pull box. Replace the affected detectors within 24 hours. Immediately begin repairs for any damaged interconnect conduit and/or cable. For failure to complete the repairs within these periods, the repairs may be made by State or local agency forces at the Contractor's expense, with the cost of performing such repairs or replacements deducted from any moneys due or to become due.

Ascertain, and be responsible for confirming the exact location, horizontally and vertically, of existing conduit runs, pull boxes, detectors and other electrical facilities before using any tools or equipment that may damage such facilities or interfere with any electrical system.

Where roadways are to remain open to traffic and existing lighting systems are to be modified, keep the lighting systems in operation and make the final connection to the modified circuit so that the modified circuit will be in operation by nightfall of the same day.

Keep temporary electrical installations in effective operation until the temporary installations are no longer required for the traveling public. Remove temporary installations according to Subsections 623.02.03, 623.02.04, and 623.02.05.

These provisions will not relieve the responsibilities as provided in Subsections 107.11 and 107.16.

A temporary overhead cable system or temporary portable signal system may be used for the existing signal system circuitry in lieu of maintaining the underground installations during construction. Provide signal heads with a 4.5 m (15 ft) minimum and a 5.8 m (19 ft) maximum clearance above the travel lane to the bottom of the signal head. For signal systems in a local area network, maintain the interconnect.

If modifying an existing system, consider work not shown on the plans or specified in the Special Provisions and necessary to keep all or any part of the existing system in effective operation as included in the prices paid for the systems, or bid items, with no additional compensation.

Should an existing system be temporarily shutdown, cover all signal heads, and establish intersection traffic control according to the MUTCD, as shown in the plans or as directed.

**623.01.07 Scheduling of Work.** Schedule work so that each traffic signal, highway lighting and sign illumination system is completed and ready for operation before opening the corresponding section of the roadway to traffic.

Do not place traffic signals in operation for use by public traffic without the energizing of street lighting at the intersection to be controlled if street lighting exists or is being installed in conjunction with the traffic signals.

Do not place traffic signals in operation until the roadways to be controlled are open to public traffic.

Do not place highway lighting and traffic signals in operation, including flashing operation, before commencement of the functional test period specified in Subsection 623.03.21.

Do not pull conductors into conduit until pull boxes are set as specified to Subsection 623.02.17.

In rural areas, place traffic signals at new locations in flashing operation for a minimum of 24 hours before switching to normal operation. In urban areas or areas where driver familiarity exists, flash or turn on as directed and in concurrence with the local traffic agency.

If soffit lights or lighting for pedestrian structures are ordered placed in operation before permanent power service is available, the cost of installing and removing temporary power service will be paid for as extra work as provided in Subsection 104.03.

**623.01.08 Safety Precautions.** Obtain a daily safety circuit clearance before starting work on existing series street lighting circuits. Pull bypass switch plugs and post proper construction signs at switch boxes before any work is done.

Do not leave electrical systems in an exposed or otherwise hazardous condition. Close and lock all electrical boxes, cabinets, pole hand-holes, or other locations which contain wiring, either energized or non-energized, during non-working hours.

Cap or otherwise seal electrical raceway or duct openings from the entrance of water and dirt. Protect all wiring from mechanical injury.

MATERIALS AND INSTALLATION

**623.02.01 Construction and Material Requirements.** Electrical work shall conform to NEC requirements and to applicable local ordinances. Obtain construction permits from State and local agency prior to constructing traffic signals, lighting systems, or other electrical installations required by the contract.

Only journeyman electricians or electrical apprentices directly supervised by a journeyman electrician shall perform electrical work or install electrical material.

All work performed on traffic signal installations must be performed or be directly supervised by a journeyman electrician certified as IMSA Level II or higher.

**623.02.02 Removing and Replacing Improvements.** Replace or reconstruct improvements such as sidewalks, curbs, gutters, Portland cement concrete and asphalt concrete pavement, base material, lawns, and plants, and any other improvements removed, broken, or damaged with the same kind of material as found on the work or with materials of equal quality at own expense. Leave the new in a serviceable and satisfactory condition.

Saw cut the outline of all areas to be removed in concrete sidewalks, driveways, and in pavements to a minimum depth of 40 mm (1.5 in.) with an abrasive type saw before removal. The cut for the remainder of the required depth may be made by a satisfactory method. Make cuts neat and true with no spalling outside the removal area.

Whenever a part of a square or slab of existing concrete sidewalk or driveway is broken or damaged, remove the entire square or slab and reconstruct the concrete as above specified.

**623.02.03 Salvaging Electrical Equipment.** Where shown on the plans or ordered, salvage for reuse by the maintaining agency the existing electrical equipment to be removed, including controller units, cabinets, signal heads, luminaires, standards, mast arms, ballasts, transformers, service equipment, pull boxes, and detector contact units.

Exercise care in removing, storing, and salvaging electrical equipment so that it will remain in its original form and existing condition. See Subsections 107.11 and 107.12. Replace any electrical equipment which is determined to have been damaged or destroyed by operations.

Unless otherwise specified, underground conduit, conductors, foundations, and detector frames not reused shall become the property of the Contractor and shall be removed from the highway right of way, except if not interfering with other construction, said materials, except foundations, may be abandoned in place.

See Subsection 623.02.13, regarding foundations to be abandoned.

Fill holes formed by removing pull boxes and foundations with material equivalent to the surrounding material.

**623.02.04 Reinstalling Salvaged Electrical Equipment.** When salvaged electrical equipment is to be reinstalled, furnish and install all necessary materials and equipment, including signal mounting brackets, anchor bolts, nuts, washers, and concrete as required to complete the new installation.

Clean, paint, and re-lamp traffic signal, flashing beacon, and lighting fixtures to be reinstalled.

Replace with new material any existing materials required to be relocated and found to be unsatisfactory. The cost therefore will be paid for as extra work as provided in Subsection 104.03.

**623.02.05 Stockpiling Salvaged Electrical Equipment.** Salvage and stockpile existing equipment removed and not reused at the designated location and as directed.

**623.02.06 Galvanizing.** Galvanize according to Section 715.

Cabinets may be constructed of material galvanized before fabrication according to ASTM A653, Coating Designation Z275.

Hot dip galvanize iron or steel pipe standards and pipe mast arms after fabrication according to ASTM A53.

Hot dip galvanize tie-rods, nuts, washers, clamps, and other miscellaneous ferrous parts after fabrication according to Section 715.

Galvanize not less than 250 mm (10 in.) of the upper end of the anchor bolts, anchor bars, or studs, and all nuts and washers according to Section 715.

After galvanizing, the bolt threads shall accept galvanized nuts without requiring tools or causing removal of protective coatings.

Galvanizing of existing materials in an electrical installation will not be required.

Coat cadmium plated bolts on lighting pole slip bases with cold galvanizing compound after installation.

**623.02.07 Painting.** Painting of electrical equipment and material shall conform to the maintaining agencies requirements.

Painting of electrical equipment and materials shall conform to Section 614, with the following additions and modifications.

Paint materials for electrical installation, unless otherwise specified, shall conform to the requirements in Section 714.

Factory or shop cleaning methods for metals will be acceptable if equal to the methods specified herein.

In lieu of the temperature and seasonal restrictions for painting as provided in Section 614, paint may be applied to equipment and material for electrical installations at any time approved.

Clean all ferrous surfaces to be painted as provided in Subsection 614.03.03 (a), before applying the prime coat. Do not blast clean galvanized metal surfaces in satisfactory condition.

Wash existing equipment to be painted in the field, including state-furnished equipment, with a stiff bristle brush using a solution of water containing 10 ml of heavy duty detergent powder per liter (2 tablespoons/gal). After rinsing, wire brush surfaces with a coarse, cup shaped, power driven brush to remove all poorly bonded paint, rust, scale, corrosion, grease, or dirt. Remove any dust or residue, remaining after wire brushing, before priming.

Unless otherwise specified, galvanized metal poles and metal guard posts will not require painting.

Unless otherwise specified, apply two finishing coats of Aluminum Paint conforming to Section 714 to the following non-galvanized equipment: Reused lighting and signal standards, and reused luminaires; and to exterior surfaces and un-galvanized steel edges of rain-tight enclosures (switches, service, control equipment, transformers, etc.).

Paint or powder coat signal controller cabinets white.

Finish the interior of signal hoods, louvers, and front faces of back plates with two coats of Enamel; Traffic Signal, Lusterless, Black, as provided in Section 714, except that factory enamel finish in good condition will be acceptable.

Finish signal heads, signal head mounting, brackets and fittings, outside of hoods, pedestrian push button housings, pedestrian signal head housings and hoods, and back faces of back plates with two coats of Enamel; Traffic Signal, Dark Olive Green, as provided in Section 714.

Painting of outside of signal heads and other signal equipment which have been factory enameled in dark olive green and are in good condition, may be omitted.

Factory finish on new equipment will be acceptable if of proper color and if equal in quality to the specified finish.

Finish all conduit and conduit fittings that are above ground in the same manner as adjacent standard or post.

Give reused equipment, that was previously galvanized, two finishing coats over the entire surface of repaired areas.

Clean and paint reused galvanized equipment that has extensively rusted areas as provided for non-galvanized equipment.

Clean and paint small rusted or repaired areas of reused galvanized equipment as provided for repairing damaged galvanized surfaces.

Apply paint coats either by hand brushing or by approved spraying machines. Perform the work in a neat and workmanlike manner. The right is reserved to require the use of brushes for the application of paint, should the work done by the paint spraying machine prove unsatisfactory or objectionable.

## SERVICE SYSTEMS

**623.02.08 Service.** Electrical service installation and materials shall conform to the requirements of the serving utility, and the requirements of NEC Article 230. Use service pedestals listed in the QPL.

Install service equipment as soon as possible to enable the utility to schedule work well in advance of the completion of the project.

Energy used before completion of the contract will be charged to the Contractor, except that the cost of energy used for public benefit, when such operation is ordered, will be at the expense of the State or local authorities.

Full compensation for furnishing and installing service poles, service equipment, trenching, conduit, weatherhead, conductors (including equipment, conduit, and conductors, placed on utility owned poles, and the additional conductor where the serving utility requires three wire, 120/240 V service into the meter socket for a 120 V load), and for any service connection fees, will be included in the contract item underground or overhead electrical service and no additional compensation will be allowed therefore.

Provide service conduit and risers for multiple lighting or traffic signals meeting the requirements of the serving utility, where applicable, and the requirements of the NEC. Provide service conduit for multiple lighting and traffic signals not less than 50 mm (2 in.) in size.

Provide electrical service installation and materials that conform to the requirements of the serving utility.

If specified, supply an approved weatherhead.

When the service equipment is to be installed on a utility-owned pole, furnish and install conduit, conductors and all other necessary material to complete the installation of the service. The position of the riser and equipment will be according to the utility requirements.

Service conduit shall conform to the requirements of the serving utility and shall be not less than Schedule 40.

Where a kilowatt-hour meter is required, furnish and install a meter socket with a sealing ring, as approved by the serving utility. Where a meter socket is installed, provide the meter enclosure with a factory installed test bypass facility as required by the serving utility.

Install service equipment as soon as possible to enable the utility to schedule its work well in advance of the completion of the project or need for power. Give notification upon installation of new improvements so the Department can schedule inspection by the serving utility.

Provide each service with a circuit breaker which can simultaneously disconnect all ungrounded service entrance conductors.

Provide quick-break on either automatic or manual operation circuit breakers. The operating mechanism shall be enclosed and shall be trip-free from the operating handle on overload. Circuit breakers shall be trip-indicating, shall have frame size plainly marked and shall have trip rating clearly indicated on the operating handle. Overload tripping of breakers shall not be influenced by an ambient temperature range of from –18 °C (–0.4 °F) to 50 °C (122 °F). Multiple-pole breakers shall be the internal trip type. All circuit breakers shall be listed by UL or ETL. Current rating of breakers shall be as shown on the plans. Circuit breakers used as service disconnect equipment shall have a minimum interrupting capacity of 10,000 A, rms. Enclose circuit breakers in a NEMA rain-tight enclosure with dead-front panel and hasp with a 11 mm (7/16 in.) hole for a padlock. The padlock will be furnished by the Department.

Finish service equipment enclosures as required by the maintaining agency. In the absence of agency requirements, powder coat white or with a color as specified.

Fabricate service equipment enclosures from galvanized sheet steel, aluminum, or sheet steel that is zinc or cadmium plated after fabrication. Paint steel enclosures according to Subsection 623.02.07. Overlapping exterior seams and doors shall meet the requirements for Type 3R enclosures specified in the NEMA Enclosure Standards.

If an alternative design is proposed for service equipment enclosures, submit plans of that design for approval.

Full compensation for furnishing and installing State-owned or permanent service poles, service equipment, conduit, conductors and pull boxes (including equipment, conduit and conductors placed on utility-owned poles) shall be considered as included in the contract item of electrical work involved and no additional compensation will be allowed therefore.

Where the service point is indeterminate and is shown on the plans as an “approximate location” or “service point not yet established,” the cost for making the connection between the service point, when established, and the nearest pull box shown on the plans will be paid for as extra work as provided in Subsection 104.03.

**623.02.09 Transformers.** Multiple to multiple and series to multiple transformers shall be of the single-phase, dry type designed for operation of a 60 Hz supply.

(a) Electrical Requirements. Transformer ratings shall be 120 to 480 V, 240 to 480 V, or 480 to 120 V for multiple to multiple units and 6.6 A to 118 V or 6.6 A to 480 V for series to multiple units or other ratings as shown on the plans.

Center tap secondary 480 V windings and ground the center tap.

Special taps for high or low voltages will not be required.

Volt-ampere ratings shall be as shown on the plans.

Do not exceed transformer efficiency of 95% for multiple to multiple units and 80% for series to multiple units.

Average temperature rise of windings, at full load, shall conform to NEMA requirements for Class A insulation.

Provide secondary voltage regulation and tolerance of ± 3% from half load to full load for multiple to multiple units and +10% (maximum) at no load to ± 3% at full load for series to multiple units.

Provide external leads for multiple to multiple and series to multiple secondary connections of Type RHWUSE, No. 10, rated 600 V, AC. Primary conductors for series to multiple transformers shall be rated for use on 5,000 V, AC circuits.

Provide transformer insulation of NEMA Class F or better.

Use potting compound conforming to the temperature requirements of NEMA Class A insulation.

Series to multiple transformers shall withstand the application of 12,000 V (RMS, 60 Hz) from core to primary coil and from coil to coil for 1 minute period.

Series to multiple transformer secondaries and multiple to multiple transformers shall withstand the application of 2,200 V (RMS, 60 Hz) from core to coils, and, for multiple units only, from coil to coil for a 1 minute period.

Make the above test immediately after operation of the transformer at full load for 24 hours.

(b) Physical Requirements. Securely encase submersible type transformers in a rugged, corrosion resistant, watertight case which can withstand a 5 day test submerged in 610 mm (2 ft) of salt water (2% salt by mass) with 12 hour on and off periods. The operating periods shall be at full load.

Submersible units shall be capable of withstanding a shock test as specified in MIL-STD- 202; Test Method 205; Test Condition C. Mounting for shock test may be by any convenient means.

Proof of performance after the above tests shall be as follows:

l. Continuity in all windings.

2. Insulation test at 90% of initial test voltage.

3. No evidence of physical damage such as cracks.

Provide each transformer to be installed in a pull box of the submersible type and provide with a handle and a hanger as shown on the plans for ballast installation in pull box.

Provide nonsubmersible transformer units with metal half-shell coil protection, with moisture resistant, synthetic varnish impregnated windings and suitable for outdoor operation in a rain-tight enclosure.

Extend transformer leads a minimum of 300 mm (12 in.) from the case. Bring leads of submersible units out through 1 sealed hub and secure in a manner which will withstand a 450 N (101 lb) static pull without loosening or leaking.

**623.02.10 Photoelectric Controls.** Provide photoelectric controls, of the type as specified in the Special Provisions or as shown on the plans capable of switching multiple lighting systems directly through a high voltage controller.

(a) Types. Type I photoelectric control shall consist of a photoelectric unit and a contactor in a single weatherproof housing.

Type II photoelectric control shall consist of a photoelectric unit in a weatherproof housing and a separate contactor located in a traffic signal controller cabinet.

Type III photoelectric control shall consist of a photoelectric unit and a separate contactor, each in a separate weatherproof housing.

Type IV photoelectric control shall consist of a photoelectric unit in a weatherproof housing which plugs into an EEI-NEMA twist lock receptacle integral with the luminaire.

Provide a switch to permit manual operation of the lighting circuit for each Type I, Type II, and Type III photoelectric control. Provide switches of the single-hole mounting toggle type, single-pole, single-throw, rated at 12 A, 125 V. Furnish switches with an indicating nameplate reading “Auto-Test” and connect in parallel with the load contacts of the photoelectric unit.

(b) Photoelectric Unit. The photoelectric unit shall provide an output in response to changing light levels. The response level shall remain stable throughout the life of the control unit. Components of the unit shall not require periodic replacement.

Units for highway lighting shall have a “turn-on” between 10 and 54 lx (1 and 5 foot candles) and a “turnoff” at between 1.5 and 5 times “turn-on.”

Units for illuminated signs shall have a “turn-on” level of between 210 and 320 lx (20 and 30 foot candles). Turn-on level specified above corresponds to a switching level of approximately 430 to 650 lx (40 to 60 foot candles) measured in the horizontal plane. “Turn-off” level shall not exceed 3 times “turn-on” level.

Measurements shall be by the procedures set forth in EEI-NEMA Standards for Physical and Electrical Interchangeability of Light-Sensitive Control Devices Used in the Control of Roadway Lighting.

Furnish photoelectric controls, except Type IV, with a 100 mm (4 in.) minimum inside diameter slipfitter containing a terminal block and with cable supports or clamps to support pole wires.

The photoelectric unit receptacle shall be the EEI-NEMA type. Use mounting brackets where pole-top mounting is not possible. Install photoelectric controls at the locations shown on the plans and orient as directed.

For switching 480 V, 60 Hz circuits, install 100 VA, minimum, 480 to 120 V transformer in the contactor enclosure to provide 120 V for the photoelectric control unit. Where more than 1 photoelectric unit is to be installed at the same location, a single transformer, with a VA rating capable of handling the total controlled load, may be used.

Screen photoelectric units to prevent artificial light from causing cycling.

The photoelectric unit shall also conform to the following:

1. The supply voltage rating shall be 60 Hz, 105 to 130 V, 210 to 240 V, or 105 to 240 V, as required.

2. The load rating shall be 800 W minimum, incandescent, mercury vapor or fluorescent.

3. The operating temperature range shall be from –30 to 65 °C (–20 to 150 °F).

4. The power consumption shall be less than 10 W.

5. Provide the base of the unit with a 3 prong, EEI-NEMA standard, twist-lock plug mounting.

(c) Contactor. The contactor shall have contacts rated to switch the specified lighting load and shall be normally open, unless otherwise specified.

Provide a contactor of the mechanical armature type consisting of an operating coil, a laminated core, a laminated armature, contacts and terminals. Contacts shall be fine silver, silver alloy, or a superior alternative material.

(d) Contactor and Test Switch Housing. For Type I control, the enclosure shall house the test switch only. For Type III control, house the contactor and test switch in a suitable NEMA Type 3R enclosure. Provide the enclosure with a factory applied rust-resistant prime coat and baked enamel finish coat. Apply 2 coats of aluminum as specified in Section 614. The enclosure may be hot-dip galvanized in lieu of painting. Provide a minimum of 65 mm (2.5 in.) between contactor terminals and end of enclosure for wiring connections. Mount the enclosure on the same standard as the photoelectric unit at a height of approximately 1.8 m (6 ft) above the base.

For Type II control, house the test switch in the traffic signal controller cabinet with the contactors.

(e) Wiring. Use No. 12 conductors between the photoelectric unit and an external contactor and run inside the lighting standard, or in conduit, unless otherwise shown on the plans.

STANDARDS

**623.02.11 Standards and Posts.** Standards consist of a shaft with a base, anchor bolts, mast arms, if required, and other hardware required to support the traffic signal and highway lighting system apparatus or appurtenance.

Provide complete shop drawings and material certifications for all standards (poles), including lowering devices for high masts within 15 days after award of contract.

In addition to these requirements, design structures in accordance with the requirements of the latest edition of the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals.

Locate standards for traffic signals and highway lighting and other similar equipment as shown on the plans.

Provide workmanship and finish equal to the best general practice of metal fabrication shops. Perform fabrication and welding according to the requirements of this Subsection and Section 506 with the following exception; use AWS D1.1/D1.1M in lieu of AASHTO/AWS D1.5M/D1.5.

Construct Type 1-A and Type 1-B standards of not less than 3.2 mm (11 gage) sheet steel or NPS 4, 114.3 mm (4 in.) outside diameter, standard pipe with the top designed for post-top slip-fitter.

Standard pipe shall conform to ASTM A53.

All ferrous metal parts of standards, 4.5 m (15 ft) and longer, shall conform to the details shown on the plans and as specified herein.

Fabricate standards from (a) sheet steel conforming to ASTM A572, Grade 345 (50), ASTM A595, Grade A, or ASTM A1011, Grade 340 (50); or from (b) sheet steel of weldable grade. If alternate (b) is used, the steel, after fabrication, shall have a minimum yield of 330 MPa (48,000 psi).

Standards may be fabricated of full length sheets or shorter sections. Fabricate each section from not more than two pieces of sheet steel. Where two pieces are used, locate the longitudinal welded seams directly opposite one another. When the sections are butt-welded together, place the welded seams on adjacent sections to form continuous straight seams from base to top of standard.

Fabricate Type 1A, 1B, 7, 8, 14, 16, 28, 30, 30A, 35, and 35A standards and any mast arms to a smooth round appearance with no visible angles in cross section.

Fabricate standards straight, with a permissive variation not to exceed 25 mm (1 in.) measured at the midpoint of standards greater than or equal to 8 m (26 ft) in height, and not to exceed 20 mm (0.75 in.) measured at the midpoint of standards less than 8 m (26 ft) in height.

Strengthen the butt-welded transverse joints by inserting a metal sleeve at each joint. Make the sleeve of 3.5 mm (10 gage) sheet steel and from steel having the same chemical composition as the steel in the standard. The metal sleeve shall have a minimum length of 25 mm (1 in.). Center the sleeve at the joint and with the same taper as the standard with the outside of the sleeve in full contact with the inside of the standard throughout the sleeve length and circumference.

Make welds continuous.

Extend the weld metal at the transverse joint to the sleeve, making the sleeve an integral part of the joint.

Perform longitudinal welding using submerged arc or electric resistance welding processes.

Grind exposed welds, except fillet welds, flush with the base metal.

Finish exposed edges of the plates which make up the base assembly. Smooth and neatly round exposed corners of such plates to a 3 mm (1/8 in.) radius, unless otherwise shown on the plans. Provide shafts with slipfitter shaft caps.

Provide push button posts and guard posts conforming to ASTM A53.

Repair holes left in the shafts of existing standards, due to removal of equipment or mast arms, by welding in a suitable disk, grinding smooth, and painting as provided for reused equipment in Subsection 623.02.07.

When directed, repair existing standards to be relocated or reused in place before repainting or re-galvanizing. Remove large dents, straighten shafts, and replace portions which are in poor condition due to corrosion or damage. Extent of repairs or replacements will be determined and said repairs or replacements ordered will be paid for as extra work as provided in Subsection 104.03.

Furnish anchor bolts and nuts required for relocating existing standards.

Galvanize new standards, posts, and other ferrous materials as provided in Subsection 623.02.06.

Give 15 days notification before the start of fabrication so inspection can be provided if necessary. Material not inspected at the fabrication shop will be subject to inspection in the field.

Signal poles, lighting poles, mast arms, electrical cabinets and controller cabinets within the Lake Tahoe Basin shall be primed by the manufacturer and the final two coats to be painted by the Contractor. The color shall be Dark Brown conforming to Federal Color Number 30108 as shown in Table I of Federal Standard No. 595B.

At own option or as specified in the Special Provisions or plans, the above items may be coated at the factory with a Urethane or Triglycidyl Isocyanurate (TGIC) Polyester Powder to a minimum thickness of 0.05 mm (2 mils). Electrostatically apply coating and cure in a gas fire convection oven between 175 °C (347 °F) and 205 °C (401 °F).

Aluminum light poles or fiberglass light poles may be furnished and installed in lieu of the galvanized steel standards specified above for the Type 7 and 14 standards.

Select the type of light standard to use for the entire project and do not use a combination of galvanized steel, aluminum, or fiberglass poles.

Where Type 7 and 14 standards are to be installed with existing standards, install standards of the same material composition as the existing standards.

(a) Aluminum Light Poles. Base the structural design of the aluminum light pole on the AASHTO “Standards Specifications for Structural Supports for Highways Signs, Luminaires, and Traffic Signals” for a 128 km/hr (80 mph) wind area, and a luminaire effective projected area (EPA) and weight as specified.

Tapered shafts manufactured from aluminum tubing shall conform to ASTM B221, alloy 6061-T6, 6063-T6, or 6005-T5. Tapered shafts manufactured from aluminum sheet shall conform to ASTM B209, alloy 5086-H34. Shafts manufactured from tubing shall be spun drawn, and shafts from sheet shall be formed to a smooth circular, tapered design to provide the specified mounting height.

The shoe base shall be a casting of aluminum that conforms to ASTM B108, alloy 356.0-T6, or ASTM B26, alloy 356.0-T6. Base flanges shall have continuous welds both inside and outside, unless otherwise permitted. Perform welding by the inert gas shielded arc method and produce welds free from cracks and voids. All welding shall conform to the requirements of AWS D1.2 Structural Welding Code-Aluminum, Section 10, Tubular Structures. Manufacture bolt covers from aluminum conforming to ASTM B108, alloy B443.0-F, or ASTM B26, alloy 356.0-F. Heat treat welds after welding.

Equip aluminum standards with an approved dampening device.

Use anodized aluminum or stainless steel hardware with aluminum standards. Bolts to be inserted in aluminum threads shall be stainless steel.

Provide removable bolt covers with each pole, except for poles with safety bases. These may be individual covers for each bolt or a collar. Cast or form covers of aluminum. Attach each bolt cover or section of a collar to the base by means of stainless steel screws 6 mm (0.25 in.) or larger with hexagon or Allen heads. Self-threading screws are not acceptable.

Where a safety base is required, use a safety base of breakaway couplings with an anchor base.

Install the aluminum poles with an anchor base or safety base on the Standard Pile Foundation as shown in the Standard Plans for the Type 7 and 14 poles.

Handle and prepare the aluminum poles for installation as recommended by the manufacturer.

The luminaire arms mounted on the aluminum poles shall be aluminum tube mast arms of the similar length and rise of the steel mast arms shown in the plans. Manufacture the mast arm from an aluminum alloy, extruded tube conforming to ASTM B221, alloy 6061-T6 or 6063-T6. All welding shall conform to the requirements of AWS D1.2 Structural Welding Code-Aluminum, Section 10, Tubular Structures. Heat treat welds after welding.

Supply the mast arm with fabricated aluminum brackets welded to the arm. Clamp the mast arm to the pole.

(b) Fiberglass Light Poles. Handle and prepare fiberglass poles for installation as recommended by the manufacturer.

**623.02.12 High Mast Steel Poles and Head Frame Assembly.** (a) High Mast Steel Poles. Certify in writing that the pole manufacturer has coordinated his design with the manufacturer of the high mast lowering device and that his design will accept the installation of the total system mechanically, electrically, and in all other respects.

(b) Fabrication of Steel Shafts. Furnish detailed fabrication drawings of the high mast steel poles in accordance with Subsection 105.02.

1. Fabrication. The pole may be supplied full length or in a maximum of 3 telescoping sections. Fabricate telescoping sections full length with no splices. Multi-sided poles shall have a minimum of 12 sides, which shall be convex and shall have a minimum bend radius of 100 mm (4 in.). The sections shall be cold formed. Taper the pole uniformly from top to bottom. Do not use laminated or layered steel plates for pole fabrication.

Fabricate each pole section so that it may be telescoped over the next lower section a minimum of 1.5 times the diameter of the female end of the joint. Have the telescoping sections pre-fitted and match marked by the manufacturer. Preassemble each telescoping joint to insure a proper fit. Field assemble the telescoping section as recommended by the manufacturer and in a manner approved.

Racking will not be allowed, and the manufacturer shall guarantee in writing that no settling of the joints will occur.

Fabricate each pole with a hand hole, complete with a weatherproof cover bolted to a reinforced frame or to a laminated pole section. Provide a reinforced frame or laminated pole section to restore the strength lost by the removal of metal for the hand hole. Locate the circuit breaker and winch bracket mounting plate opposite the hand hole.

Provide each pole with an interior grounding connection positioned near the base of the pole.

The pole manufacturer shall meet Standard Manufacturing Tolerance for straightness of the pole shaft.

2. Welds. Perform welding according to the latest editions of the AASHTO “Standard Specifications for Highway Signs, Luminaires and Traffic Signals” and the AWS D1.1/D1.1M, as modified herein.

Each shaft may have a maximum of two longitudinal seam welds with 60% minimum penetration. Longitudinal seam welds on the female section of telescoping shaft splices shall be full penetration groove welds for a length equal to the splice length plus 150 mm (6 in). The weld may be ground or rolled flush and smooth.

Weld the shaft to the steel base by full penetration butt welds with a suitable backup strip. Do not field weld.

Visually inspect and test all welds by one of the following methods: (1) ultrasonic method of AWS D1.1/D1.1M including revisions, (2) magnetic particle method to ASTM E709, or (3) radiographics method to ASTM E94 or E390, as applicable. Submit certified results for review.

Perform all welding and remove all weld splatter before finishing.

Use weld metal meeting the notch-toughness requirements as specified for bridge application in AWS D1.1/D1.1M including revisions.

3. Mechanical Properties. Supply high strength steel for the shaft conforming to ASTM A572, Grade 345 (50), or ASTM A595, Grade A and meeting the notch-toughness requirements of the Charpy “V” Notch Test for 20 J at 4 °C (15 ft•lb at 40 °F). Submit 4 copies of the manufacturer’s certified mill test report (chemical and physical properties) covering each heat to be used on the project. Test a minimum of 3 coupons of each heat after rolling. Retest, from the same heat, any sample showing less than the minimum yield strength. Material failing the retest will be rejected. The test reports may be the mill test reports for the as-received steel or, when the as-received steel has a lower yield strength than required, provide supportive test data which provides assurance that the method of cold forming will consistently increase the tensile properties of the steel to meet the specified minimum yield strength. The supportive test data shall include tensile properties of the steel both before and after cold forming for specific heats and thicknesses.

Fabricate all base flanges, brackets, and miscellaneous hardware from steel plate having a minimum yield strength of 248.2 MPa (36,000 psi).

4. Anchor Bolts. Material for anchor bolts shall conform to AASHTO M314, Grade 55 including S1 Supplementary Requirements. Ship anchor bolts prior to the delivery of the pole.

Install anchor bolts with a template to insure proper fit of the pole base.

Galvanize anchor bolts and nuts in accordance with ASTM A153 (AASHTO M232) a minimum of the threaded length plus 100 mm (4 in.). Provide certification.

Do not weld anchor bolts to make the required lengths. Do not tack or weld to make up the anchor cage.

Supply each anchor bolt with three hex nuts, one of which shall be a lock nut.

Torque top nut one-sixth turn beyond snug tight and lock nut snug tight. Retighten leveling nut after tightening top nut to ensure full contact is maintained.

5. Finish. Galvanize the pole, base, and miscellaneous brackets in accordance with ASTM A123 (AASHTO M111). Take precautions against embrittlement, warpage, and distortion in accordance with ASTM A143 and ASTM A384. Provide certifications.

Do not scratch the pole finish prior to and during erection. However, if the finish is damaged, make repairs in accordance with recommended materials and procedures established by the manufacturer of the finish and the pole, and as approved.

(c) High Mast Head Frame Assembly. Use high mast head frame assemblies listed in the QPL.

The lowering device manufacturer shall have a minimum of 5 years of experience manufacturing and satisfactorily installing lowering devices.

Recruit the services of the manufacturer's representative to assist in the proper installation of the lowering device. The representative shall be in attendance at installation and initial operation of lowering devices for each pole. The manufacturer shall supply a written manual for installation and operation of the lowering device, with a minimum of five copies per project or one copy per device, whichever is greater. The manufacturer's representative shall also conduct a 4 hour training session for Department maintenance personnel at completion of project. Take care not to damage the lowering device during the installation and erection of the tower.

1. Structural Design. Furnish a lowering device of proven design, construction, and materials that will assure a long, reliable, safe, and low-maintenance life, and is capable of lowering a ring of luminaires to within approximately 1 m (3 ft) of the pole base so that routine luminaire maintenance can be accomplished safely and efficiently.

Provide facilities to energize the entire ring of luminaires while the lowering device is in the lowered position. Supply each pole with a power cable and connectors for this purpose. Furnish a weatherproof, twistlock, 600 V rated service receptacle for the cable.

Attach and equally space hoisting cables to the luminaire ring. Provide a method by which the tension on the hoisting cables is equalized.

In the raised position, the luminaire ring shall be rigidly suspended from equally spaced points by either purely mechanical latches or by cables in tension as specified in the plans and as approved.

Type II (bottom latching) is required unless the plans indicate Type I (top latching) will be allowed.

For Type I (top latching), provide a positive automatic mechanical latching system which does not require manual or electrical tripping devices to either latch or unlatch the system. That portion of the latching system which is permanently attached to the top of the pole shall have no moving parts or contain any parts that require adjustment after the pole is erected. Provide visual indication of positive latching. The latching system shall not be impaired by snow or ice accumulations. When latched, all tension shall be removed from the hoisting and winch cables.

For Type II (bottom latching), provide the cables in tension system with a positive guide and positioning method to prevent rotational, horizontal, or vertical movement of the luminaire ring. Provide a method to equalize the stress on all three cables and remove all tension from the winch and cable assembly when the ring is in the raised position.

Install guide arms and/or rollers on the luminaire ring to prevent hang-up of the ring during raising and lowering, prevent damage to the finish of the tower shaft, and keep the luminaire ring equidistant from the pole at all times.

House the self-lubricating pulleys, which are located at the top of the pole, under a weather-tight cover similar in color to the support assembly.

Provide suspension highly stable and operable (raised or lowered) in 48 km/hr (30 mph) winds.

Power the lowering device winch by a lightweight, remotely controlled, portable, heavy-duty reversible type, minimum of 3/4 horsepower (560 Watt) electric motor. Provide the lowering device provisions for manual operation as a backup, in the event of a loss of power.

Provide a certification from the lowering device manufacturer that he has coordinated his design to accept the installation of the pole and high mast luminaires to insure the proper function of the total system mechanically, electrically, and in all other respects.

At the top of the pole, do not install an electromechanical disconnect in the circuits supplying power to the luminaires. Wire the power cable directly to the terminal blocks in the junction box on the luminaire ring.

Attach the power cable to the luminaire ring in such a manner as to support the full weight of the cable while in the raised position, without pulling out or causing damage to the cable.

2. Materials. Use wire rope attachments, such as thimbles for eyes, clips, compression, and swedge-type fittings approved by the manufacturer. Install and torque in accordance with the manufacturer's recommendations.

Construct the luminaire ring and mast arms of weldable, structural steel with the mast arms of 50 mm (2 in.) diameter pipes for slip-fitter connections to the high mast luminaires. Equally space the mast arms around the ring, unless otherwise specified. The number of mast arms required will be shown on the plans. Provide luminaire rings that are weatherproof and are pre-wired to distribute power from the main power cable. The mast arms shall be easily attached or removed. Furnish one mast arm for each high mast luminaire.

Fabricate the high mast support assembly from weldable structural steel and attach to the pole shaft. Devise a positive method of pole attachment in cooperation with the pole manufacturer to prevent any rotation of the support assembly on the pole top. The support assembly shall house all required pulleys and mechanical latching devices to support the luminaire ring and the luminaires.

Locate the winch assembly at the base of the pole shaft adjacent to the hand hole. Provide a winch assembly with a worm gear drive with a reduction ratio of 30:1 and of the self-locking type, equipped with a takeup guide to prevent cable overlap. Size the assembly adequately to raise and lower the luminaire ring and luminaries at a minimum rate of 3 m (10 ft) per minute. Supply the winch with an inboard and outboard support, designed for hand and mechanical operation by means of a portable electric motor. Securely attach the winch cable to the winch drum and maintain at least three wraps on the drum when the luminaire ring is in the lowered position.

When specified, equip the luminaire ring with a double FAA approved red aircraft obstruction marker and dry type transformer, mounted on the ring assembly with a suitable bracket. Pipe with conduit lock rings will not be allowed. Locate the marker so as to be visible 360 degrees around the pole and turned "on" and "off" with the luminaires. Equip the lights with a multiple transfer relay to instantly change over to a reserve lamp when operating lamp fails. Provide a plug-in type transfer relay and install in a weather tight enclosure.

Provide noncorrosive hardware materials or plate with sufficient coatings to be compatible and comparable thickness as the structural parts of the lowering device.

Secure all fasteners and pins in a manner that will preclude their becoming loosened by vibration. Use self-locking nuts, jam nuts, and cotter pins for such purposes.

Ground the pole as shown on the plans.

3. Welding. Perform welding according to Subsection 506.03.16 and AWS D1.1/D1.1M latest revisions.

Field welds will not be permitted.

Visually inspect and test all welds by one of the following methods: ultrasonic method to AWS D1.1/D1.1M, latest revisions; magnetic particle method to ASTM E709; or radiographic method to ASTM E94 or E390. Submit certified results when requested.

Complete all welding and remove all weld splatter before finishing.

4. Finish. Galvanize the high mast head frame assembly after fabrication in accordance with ASTM A123 (AASHTO M111).

**623.02.13 Foundations.** Foundations which are greater than or equal to 12 feet in depth shall be constructed according to Section 509. For all other foundations for posts, standards, pedestals and controller bases, use Class A or Class AA Portland cement concrete conforming to Section 501. When groundwater is encountered, construct foundations according to Subsection 509.03.02, and place concrete according to Subsection 509.03.12.

Place foundations monolithically where practical. Place top 50 mm (2 in.) of concrete or all of grout after the post, standard, or pedestal is in proper position and fully supported by leveling nuts, if indicated. Form the exposed portions of the foundation to present a neat appearance.

Use grout consisting of 1 part of Type 1 or 1A Portland cement and 2 parts grout aggregate, by volume and containing only sufficient moisture to permit packing. Grout aggregate shall conform to Subsection 706.03.04. Cure grout by keeping it damp for 3 days.

Keep forms true to line and grade. Finish tops of foundations for posts and standards, except special foundations, to curb or sidewalk grade or as directed. Use rigid forms and securely brace in place. Place conduit ends and anchor bolts in proper position and to proper height, and hold in place by means of a template until the concrete sets.

Use anchor bolts, anchor bars, or studs and nuts conforming to the contract documents and provide with the indicated nuts and washers. Galvanize anchor bolts, nuts, and washers according to ASTM A153.

Accomplish plumbing of standards by adjusting nuts before grouting or before the foundation is finished to final grade. Do not use shims or other similar devices for plumbing or raking of posts, standards, or pedestals.

Thoroughly moisten both forms and ground which will be in contact with the concrete before placing concrete. Do not remove forms until the concrete has thoroughly set.

Apply ordinary surface finish to exposed surfaces of concrete, as specified in Subsection 502.03.18.

Extend the foundations shown in the contract documents if conditions require additional depth. Such additional work, if directed, will be paid for as extra work as provided in Subsection 104.03.

Provide standards to be relocated with new foundations and anchor bolts of the proper type and size. Be responsible for ascertaining bolt pattern and dimensions.

Be fully responsible for verifying bolt patterns for any standards to be relocated or those of standards or cabinets provided by the Department as “State Furnished Equipment.”

For curing time for foundations, refer to Subsection 502.03.21. Do not erect posts, poles, standards (including high mast), and pedestals, until the concrete in the foundations has met these requirements. Plumb or rake as directed.

In unpaved areas, place a raised pad of Portland cement concrete of the size shown on the plans in front of each controller cabinet.

Provide grounding of foundations for standards, pedestals, cabinets, and sign structures containing electrically energized equipment according to Article 250 of the NEC. Use copper grounding or bonding conductors.

Abandonment of Foundations. When a foundation is to be abandoned in place, remove the top of the foundation, anchor bolts, and conduits to a depth of 150 mm (6 in.) below the surface of sidewalk or unimproved ground. Backfill the resulting hole with approved material. There will be no direct payment for this work.

**623.02.14 Trenching, Excavating, and Backfilling.** Perform the excavations required for the installation of conduit, foundations, and other appurtenances in such a manner as to avoid any unnecessary damage to street, sidewalks, landscaping, and other improvements. Do not excavate trenches wider than necessary for the proper installation of the electrical appurtenances and foundations. Perform excavation immediately before installation of conduit and other appurtenances. Place the material from the excavation in a position that will not cause damage or obstruction to vehicular and pedestrian traffic nor interfere with surface drainage.

Unless permitted in writing, remove and dispose of surplus excavated material according to Subsection 107.14.

Backfill the excavations according to Section 207.

Maintain backfilled excavations in a smooth and well-drained condition until permanent repairs are made.

Fill excavations, and restore sidewalks, pavement, and landscaping at each intersection before excavating at any other intersection, unless otherwise permitted.

Perform excavations in the street or highway in such a manner that not more than one traffic lane is restricted in either direction at any time.

Meet the requirements of the serving utility when trenching, backfilling and installing conduit from the utility power source to the utility transformer, and from the transformer to the metering equipment.

Construct the bottom of trenches for rigid nonmetallic conduit relatively free of sharp irregularities which would cause pinching and excessive bending of the conduit. Excavate the trench to 100 mm (4 in.) below the invert grade of the conduit and backfill with a granular material with 100% passing the 9.5 mm (3/8 in.) size sieve except where backfilled with slurry cement. Make a cradle shape in the granular material cushion to support the conduit. For the first 150 mm (6 in.) of backfill over the top of the conduit use this granular material. Backfill the top 100 mm (4 in.) and compact as shown on the plans or as directed.

When trenching in the existing pavement is specifically allowed or required, perform trenching and conduit installation according to Standard Plan Sheet T 30.1.2.1 and the following:

1. Make the trench no wider than necessary for the conduit to be installed.

2. Use conduit of the rigid nonmetallic type. Use sand bedding conforming to the sieve size requirements for fine aggregate specified in Subsection 706.03.03. Use slurry cement backfill conforming to Subsection 207.02.02.

3. Before placing surface material, apply tack coat as specified in Section 405.

4. Backfill excavated areas in the pavement by the end of each shift.

5. In areas where the pavement is to be rehabilitated or additional pavement is to be placed, complete conduit installation before performing such work.

When trenching roadways under jurisdiction of other agencies, perform work according to the requirements of the maintaining agency.

**623.02.15 Wood Poles.** Use wood poles for service or temporary installations of ASA Class 5, or larger, Douglas Fir or Southern Yellow Pine.

Use poles with not more than 180 degrees twist in grain over the full length. Sweep shall be no more than 100 mm (4 in.). Bevel top of poles. Place poles in the ground to a depth of at least 2 m (6 ft). The lengths of poles shall be 7.5 m (25 ft) for service poles and 10.5 m (35 ft) for other poles, unless otherwise specified.

After each wood pole is set in the ground, backfill the space around the pole with selected earth or sand, free of rocks and other deleterious material, placed in layers approximately 100 mm (4 in.) in depth. Moisten and thoroughly compact each layer.

Mast arms and tie rods for wood pole installations shall conform to Subsection 623.02.11, and to the details shown on the plans. Provide each mast arm with an insulated wire inlet and wood pile mounting brackets for mast arm and tie rod cross arm.

Mount mast arms for luminaires to provide a mounting height of 9 m (30 ft). Mast arms for traffic signals, flashing beacons, and overhead detectors shall provide a minimum vertical clearance of 5.2 m (17 ft) from bottom of equipment to the pavement.

Pressure treat wood poles, that are not designated to be painted, as provided in Section 718.

ELECTRICAL

**623.02.16 Conduit.** Run all conductors, multiple conductor cable, and fiber optic cable in conduit, except for overhead and temporary installations and where runs are inside poles.

Provide conduit of the sizes shown on the plans or as specified in this Subsection. At own option and expense, conduit of a larger size than that shown or specified may be used provided the larger size is used for the entire length of the run from outlet to outlet. Do not use reducing couplings.

Submit a certificate of compliance conforming to Subsection 106.05.

Where rigid metallic conduit is used underground, either tar and wrap or spirally wrap it with a corrosion protective polyvinyl chloride or polyethylene pressure sensitive tape, applied with a suitable primer. Use wrap having a nominal thickness of 0.5 mm (20 mils), consisting of either one layer of 0.5 mm (20 mils) tape or two separate layers of 0.25 mm (10 mils) tape. A single wrap of 0.25 mm (10 mils) tape with a half lap will not be acceptable.

Provide rigid metallic conduit meeting the requirements of NEC Article 346 and rigid nonmetallic conduit meeting the requirements of NEC Article 347. Nonmetallic conduit to be installed underground may also be High Density Polyethylene (HDPE) conduit with or without conductors pre-installed. Provide HDPE conduit conforming to UL Standard for Type A and EB rigid PVC conduit, and HDPE conduit with conductors conforming to Publication UL 651A and NEC Article 343.

Furnish conduit to be installed on the surface of poles or structures or other exposed locations of the rigid metal type and unpainted, except paint that exposed conduit installed on a painted structure the same color as the structure.

Where existing rigid metal conduit runs are to be modified or extended, only install conduit of the same material.

Install a pull box whenever an underground conduit changes from the metallic type to non-metallic type.

Where a pull box is installed adjacent to the base of an electrolier, conduit installed from the pull box to the standard shall not be less than 80 mm (3 in.) in diameter.

Where pull boxes are adjacent to the base of signal standards, other than 1-A or 1-B poles, install two 80 mm (3 in.) conduit between the pull box and signal standard. Use one 80 mm (3 in.) conduit for 1-A and 1-B installations.

Use a minimum of four 80 mm (3 in.) conduits between the pull box and controller cabinet pedestal.

Provide conduit for detector runs of not less than 50 mm (2 in.) in diameter. For all conduit not otherwise specified provide conduit 50 mm (2 in.) in diameter.

Install conduit running from a pull box to soffit, wall, or other lights or fixtures below the grade of the pull box in the end of the pull box with the centerline of the conduit terminus a minimum of 125 mm (5 in.) above the bottom of the pull box.

On conduit runs that contain signal cable exceeding 15 m (50 ft) in length, use PVC factory coated rigid metallic bends. On conduit runs 15 m (50 ft) or less, PVC factory coated rigid metallic bends or PVC Schedule 40 conduit bends may be used.

Install conduit according to the codes and regulations listed in Subsection 623.01.03.

Seal the ends of the conduits in pull boxes with duct sealing compound. Use duct sealing compound listed in the QPL.

Conduit runs shown on the plans may be changed to avoid underground obstructions when approved.

Ream the ends of all conduits, whether shop or field cut, to remove burrs and rough edges. Make cuts square and true so that the ends will butt or come together for the full circumference thereof. Do not use slip joints or running threads for coupling conduit. When a standard coupling cannot be used for coupling metal type conduit, use a UL or ETL approved threaded union coupling. Paint the threads on all ferrous metal conduit with rust preventive paint before couplings are made. Tighten couplings for metal type until the ends of the conduits are brought together, providing a sound electrical connection throughout the entire length of the conduit run. Where the coating on metal conduit has been damaged in handling or installing, paint such damaged places with rust preventive paint. Paint exposed un-galvanized threads on metal conduit resulting from field cuts with rust preventive paint. Cut nonmetallic type conduit with a hacksaw or other approved tool that will not deform the conduit. Use nonmetallic type conduit connections of the solvent weld type.

Thread metal type conduit ends and cap with standard pipe caps until wiring is started. When caps are removed, provide the threaded ends with conduit bushings. Provide metal conduits terminating in pull boxes or foundations with insulated bonding bushings. Use bonding bushings of the galvanized or zinc alloy type. Use bushings for nonmetallic conduit of the non-metallic type. Cap nonmetallic type conduit ends until wiring is started.

Provide conduit bends, except factory bends, with a radius of not less than six times the inside diameter of the conduit. Where factory bends are not used, bend the conduit, without crimping or flattening, using the longest radius practicable.

Do not bend HDPE conduit to a radius smaller than the minimum bend radius specified by the conduit manufacturer. Bend plastic coated conduit with a standard bending tool designed for use on plastic coated conduit, and which does not produce burrs and pits. Use methods recommended by the conduit manufacturer for bending of nonmetallic conduit, and with the equipment approved for that purpose. Use equipment that does not expose conduit to direct flame.

Install a nylon pull cord in all conduits which are to receive future conductors. Coil at least 1.5 m (5 ft) of pull string slack up at each termination.

Clean existing underground conduit to be incorporated into a new system with a mandrel or cylindrical wire brush and blow out with compressed air.

Lay conduit to a depth of not less than 450 mm (18 in.) below the curb grade in sidewalk areas and curbed paved median areas, 600 mm (24 in.) below highway pavement grade in road areas and finished grade in all other areas, except that conduit may be laid 300 mm (12 in.) below the top of the existing pavement within new curbed medians being constructed on top of said pavement.

Place conduit runs parallel to curbs adjacent to back of curb, except where in conflict with existing facilities.

Extend conduit stubs from electrolier bases at least 150 mm (6 in.) from face of foundation and at least 450 mm (18 in.) below top of foundation.

If jacking or drilling methods are required, do not disturb pavement without permission. In the event obstructions are encountered, upon approval, small test holes of approved size may be cut in the pavement to locate or remove obstructions. Keep jacking or drilling pits 1 m (3 ft) clear of the edge of any type of pavement wherever possible. Do not use excessive water, such that pavement might be undermined, or sub-grade softened.

Use conduit as recommended by the drilling/jacking company that accommodates or exceeds the requirements of the design.

Conduit to be placed beneath railroad tracks shall comply with the following:

1. Use conduit of rigid metal type, 40 mm (1.5 in.) minimum diameter size and place to a minimum depth of 1 m (3 ft) below bottom of tie. Construct the near side of each conduit jacking pit not less than 3.6 m (12 ft) from the centerline of track. When the jacking pit is to be left overnight, cover it with approved planking.

2. Extend conduit terminating in standards or pedestals not more than 50 mm (2 in.) vertically above the foundation and slope towards the handhold opening. Terminate conduit entering through the side of nonmetallic pull boxes not more than 50 mm (2 in.) inside the box wall and not less than 50 mm (2 in.) above the bottom, and slope toward top of box to facilitate pulling of conductors. Terminate conduit entering through the bottom of a pull box 25 to 50 mm (1 to 2 in.) above the bottom and locate near the end walls to leave the major portion of the box clear. Enter from the direction of the run at all outlets.

Seal underground conduit runs, which are adjacent to gasoline service stations or other installations of underground gasoline or diesel storage, piping, or pumps, and which lead to a controller cabinet, circuit breaker panel, service, or any enclosure where an arc may occur during normal operations if such conduit is within the limits specified in the NEC for Class 1, Division 1, Hazardous Locations. Use rigid metal conduit for such runs.

Thread and cap conduit for future use in structures. Seal conduit leading to soffit, wall, or other lights or fixtures below the grade of the pull box by means of a sealing fitting and sealing compound. Such sealing will not be required where conduit terminates in a structure pull box.

Support conduits in or on walls or bridge superstructures as shown on the plans, and as follows:

1. Use steel hangers, steel brackets, and other fittings conforming to Section 712.

2. Use cast-in-place metal inserts for hangers or brackets capable of developing 138 MPa (20,000 psi) in tension on the net section of the bolt or threaded rod.

3. Use pipe sleeves or form openings for conduits through bridge superstructure concrete.

4. Where conduits pass through the abutment concrete, wrap the conduits with two layers of asphalt-felt building paper, conforming to ASTM D226, Type I, securely taped or wired in place.

5. Fill the space around conduits through bridge abutment walls with Portland cement mortar. The mortar shall consist of 1 part Portland cement and 3 parts of mortar aggregate. Mortar aggregate shall conform to Subsection 706.03.04.

6. When the bridge superstructure is to be prestressed, do not fill the space around conduits through abutments until the pre-stressing has been completed.

7. Place conduit runs on the surface of structures straight and true, horizontal or vertical on the walls and parallel to walls on ceilings or other similar surfaces. Secure conduit with galvanized malleable iron clamps spaced not more than 1.5 m (5 ft) apart.

Where pull boxes are placed in conduit runs, fit the conduit with threaded bushings and bond. See Subsection 623.02.22.

Mark the location of ends of all conduits in structures, or terminating at curbs, by a “Y” at least 75 mm (3 in.) high cut into the face of curb, gutter, or wall, directly above the conduit and above grade line.

**623.02.17 Pull Boxes and Junction/Splice Boxes.** Provide traffic rated pull boxes and install at the locations shown on the plans.

(a) Materials. Provide pull boxes, covers, and extensions for installation in the ground or in sidewalk areas of the sizes and details shown on the plans and of precast reinforced concrete, except that alternative materials and designs may be used if units of equal strength, without excessive deflection, can be provided. Material shall be self-extinguishing when tested according to ASTM D635, with no appreciable change in physical properties when exposed to the weather.

Where a ballast or transformer is to be placed in a nonmetallic pull box, provide a box with recesses for a hanger as shown on the plans. When a vertical force of 6,700 N (1,500 lb) is applied, through a 13 mm (0.5 in.) by 75 mm (3 in.) by 150 mm (6 in.) steel plate, to a plastic cover in place on a pull box, the cover shall not fail and shall not deflect more than 6 mm (0.25 in.). Center the steel plate on the cover with its longitudinal axis coinciding with the longitudinal axis of the cover.

Pull boxes and covers shall sustain an HS20 loading as described in the AASHTO Concrete Pipe Design Manual, Illustration 4.5—AASHTO Live Loads.

Ground steel pull box covers to jumper cables.

Provide pull boxes and covers for installation in structures of the sizes and details shown on the plans. In lieu of the structure pull box shown on the plans, a telescoping steel pull box, with interior dimensions, conduit entrances, and cast iron cover conforming to the details shown on the plans may be used. Submit design of the steel pull box for review before fabrication.

Secure covers with 9.5 mm (3/8 in.) bolts, capscrews, or studs, and nuts which shall be of brass, stainless steel, or other noncorroding material. Supply stainless steel hold-down bolts, cap screws, or studs, and nuts and washers with a chromium content of not less than 18% and a nickel content of not less than 8%. Recess nuts below the surface of the cover.

Construct junction boxes for installation in structures as shown in the plans.

Provide junction boxes which are to be placed in concrete barrier rails, as indicated on the plans, with covers installed in a manner that will result in the cover conforming to the contours of, and flush with, the exterior of the barrier rail.

Galvanize ferrous metal parts according to Subsection 623.02.06.

(b) Cover Marking. Mark covers for pull boxes as follows:

1. “Traffic Signal” where pull box contains traffic signal conductors with or without street lighting conductors.

2. “Street Lighting” where pull box contains street lighting conductors only. Below “Street Lighting,” inscribe “HIGH VOLTAGE” where voltage is 480 V or higher.

3. “Communication” where communication conduit enters the pull box.

4. “Sprinkler Control” where sprinkler control conduit enters the pull box.

5. “Count Station” where traffic count station conduit enters the pull box.

6. “Ramp Meter” where ramp metering conduit enters the pull box.

Use letters heights between 25 and 75 mm (1 and 3 in.).

Apply markings to each steel or cast iron cover before galvanizing by one of the following methods:

1. Cast iron strips, at least 6 mm (1/4 in.) thick, with the letters raised a minimum of 1.5 mm (1/16 in.). Fasten strips to covers with 6 mm (1/4 in.) flathead stainless steel machine bolts and nuts. Peen bolts after tightening.

2. Sheet steel strips, at least 0.8 mm (22 gage) with the letters raised a minimum of 1.5 mm (1/16 in.) above the surrounding surface of the strips. Fasten strips to covers by spot welding, tack welding, or brazing, or with 6 mm (1/4 in.) roundhead stainless steel machine bolts and nuts. Peen bolts after tightening.

3. Bead weld the letters on the covers. Raise the letters at least 2.5 mm (3/32 in.).

(c) Installation and Use. Install pull boxes at the locations shown on the plans or, in long runs, spaced at not over 75 m (250 ft) intervals. At own expense, additional pull boxes may be installed to facilitate work.

Place the tops of pull boxes installed in the ground or in sidewalk areas flush with the surrounding grade or top of adjacent curb. Where practical, place pull boxes shown in the vicinity of curbs adjacent to the back of curb, and adjacent to standards along the side of the foundations as shown on the plans.

Bed the bottoms of pull boxes installed in the ground or in sidewalk areas in crushed rock as shown on the plans and grout before the installation of conductors. Place a layer of roofing paper between the grout and the crushed rock sump. Provide a 25 mm (1 in.) drain in the center of the pull box through the grout and the roofing paper. Place the grout between 13 and 25 mm (0.5 and 1 in.) thick and slope toward the drain hole.

**623.02.18 Expansion Fittings.** Install expansion fittings, as detailed on the plans, where the conduit crosses an expansion joint in the structure. Provide each expansion fitting with a copper bonding jumper having the ampacity required by the NEC.

Provide expansion-deflection fittings of a molded neoprene sleeve with a bonding jumper passing through a separate waterproof compartment and two silicon bronze couplings. Fittings shall allow a minimum of 20 mm (0.75 in.) expansion and contraction and 20 mm (0.75 in.) deflection without deformation.

**623.02.19 Conductors.** Conductors shall consist of solid or stranded copper of the gage shown on the plans unless specified otherwise. Provide copper wire conforming to ASTM B3 and B8. All wire size numbers shown on the plans and specified herein for conductors are AWG.

(a) Traffic Signal and Multiple Lighting Conductors. Conductors for traffic signal, flashing beacon and multiple lighting installations shall be UL listed and rated for 600 V operation. The insulation for No. 14 and larger conductors shall have one of the following insulations only:

1. Type TW, Flame-Retardant, Moisture-Resistant Thermoplastic.

2. Type THW, Flame-Retardant, Moisture and Heat-Resistant Thermoplastic.

3. Type THHW, Flame-Retardant, Moisture and Heat-Resistant Thermoplastic.

4. Type RHW, Flame-Retardant, Moisture-Resistant Thermoset.

5. Type RHW-2, Flame-Retardant, Moisture-Resistant Thermoset.

Minimum thickness of any of the above insulations shall be as required by the NEC.

Within steel poles, mast arms, and solar photovoltaic systems only, insulation for No. 10, 12 and 14 conductors may be Type UF, rated 600 V.

(b) Controller Cabinets. All wire used in controller cabinets shall be copper. All wire No. 14 to 30 AWG shall be stranded. Size wires per the ampacity ratings of the following:

| Wire Ampacity Requirements | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| AWG Wire Size | 30-24 | 22 | 20 | 18 | 16 | 14 | 12 | 10 | 8 | 6 |
| Ampacity Rating | 0.25 | 2 | 4 | 5 | 10 | 15 | 20 | 30 | 50 | 70 |

Provide conductors conforming to military specification MIL-W-16878D, Electrical Insulated High Temperature Wire, type B. Conductors No. 14 AWG or larger shall be permitted to be UL type THHN.

Do not splice conductors between terminations.

Cable may be used in lieu of individual conductors to interconnect equipment or panels within the controller cabinet. Construct the cable of No. 28 AWG or larger conductors. Furnish insulation having a voltage rating of 300 V minimum and rated for use at 105 °C (221 °F). Provide cables with strain relief.

Use No. 10 or larger conductors in traffic signal controller cabinets between service terminals and the “AC+” terminals on external light relays (including connections to the police panel switches), the signal light neutral and all conductors in the highway lighting circuit within the controller cabinet. Use No. 14 conductors in all other signal light circuits.

(c) Wall Luminaires. Use conductor Type SA stranded copper, insulated with silicone rubber and glass or other suitable braid material for use at temperatures up to 200 °C (392 °F) for wiring flush wall luminaires.

(d) Overhead Lighting. Use No. 8 or larger medium hard drawn copper with weatherproof covering.

(e) Vehicle detectors. Vehicle detector conductors and lead-in cable are specified in Subsection 623.02.30. For optical detector cable, use three conductor, No. 20 cable and 3M Model 138, Belden No. 8723 or approved equal.

(f) Traffic Signal Cable. Install individual signal cable between the controller cabinet and the terminal block in the pole mounted signal head for each signal pole. Use individual signal conductors only between the terminal block and each signal head. Use cable conforming to IMSA Specification No. 20-1 and sized as indicated on the plans.

(g) Interconnect. Use cable meeting the requirements of RUS 7 CFR 1755.390 unless otherwise noted on the plans. Supply copper shield when required by the maintaining agency.

(h) Conductor Identification. Mark all conductors and cables with clear, distinctive, and permanent markings on the outer surface throughout the entire length. Such marking shall show the manufacturer’s name or trademark, insulation type-letter designation, conductor size, voltage rating, and the number of conductors if a cable.

Supply conductor insulation with a solid color or of basic colors with a permanent continuous colored identification stripe as detailed in the following “Conductor Table” unless otherwise specified.

| Conductor Table | | | | | |
|---|---|---|---|---|---|
| **Circuit** | **Signal Phase or Function** | **Identification and Insulation Band Colors** | | | |
| | | **Base** | **Stripe (a)** | **Symbol (f)** | **Size** |
| Vehicle Signals (d) | 2, 6 | Red, Yellow, Brown | Black | 2, 6 | 14 |
| | 4, 8 | Red, Yellow, Brown | Orange | 4, 8 | 14 |
| | 1, 5 | Red, Yellow, Brown | None | 1, 5 | 14 |
| | 3, 7 | Red, Yellow, Brown | Purple | 3, 7 | 14 |
| | Ramp Meter 1 | Red, Yellow, Brown | None | NBR | 14 |
| | Ramp Meter 2 | Red, Yellow, Brown | Black | NBR | 14 |
| Pedestrian Signals (d) | 2p, 6p | Red, Brown | Black | 2p, 6p | 14 |
| | 4p, 8p | Red, Brown | Orange | 4p, 8p | 14 |
| | 1p, 5p | Red, Brown | None | 1p, 5p | 14 |
| | 3p, 7p | Red, Brown | Purple | 3p, 7p | 14 |
| Pedestrian Push Buttons (d) | 2p, 6p | Blue | Black | P-2, P-6 | 14 |
| | 4p, 8p | Blue | Orange | P-4, P-8 | 14 |
| | 1p, 5p | Blue | None | P-1, P-5 | 14 |
| | 3p, 7p | Blue | Purple | P-3, P-7 | 14 |
| Traffic Signal Controller Cabinet | Ungrounded between Service | Black | None | CON-1 | 6 |
| | Switch & Cabinet | Red | None | CON-2 | 6 |
| Highway Lighting Pull Box to Luminaire (i) | Ungrounded-Line 1 | Black | None | NBR | 14 |
| | Ungrounded-Line 2 | Red | None | NBR | 14 |
| | Grounded | White | None | NBR | 14 |
| Multiple Highway Lighting | Ungrounded-Line 1 | Black | None | ML1 | 10 |
| | Ungrounded-Line 2 | Red | None | ML2 | 10 |
| Lighting Control Photoelectric unit (PEU) | Ungrounded to PEU | Black | None | C1 | 14 |
| | Switching leg from PEU unit or SM transformer | Red | None | C2 | 14 |
| Multiple Service | Ungrounded-Line 1 (Signals) | Black | None | (e) | 6 |
| | Ungrounded-Line 2 (Lighting) | Red (j) | None | (e) | 8 |
| Sign Lighting (h) | Ungrounded-Line 1 | Black | None | SL-1 | 10 |
| | Ungrounded-Line 2 | Red | None | SL-2 | 10 |
| Flashing Beacons (g) | Ungrounded between Flasher and Beacons | Red or Yellow | None | F-Loc. (c) | 14 |
| Grounded and Common | Pedestrian Push Buttons | White | Black | NBR | 14 |
| | Signals and Multiple Lighting | White | None | NBR | 10 |
| | Flashing Beacons and Sign Lighting | White | None | NBR | 12 |
| | Lighting Control | White | None | C-3 | 14 |
| | Multiple Service | White | None | NBR | 14 |
| Railroad | Pre-Emption | Black | None | R | 14 |
| Spares | | Black | None | NBR | 14 |

(a) On overlaps, insulation is striped for first phase in designation. E.g., phase (2+3) conductor is striped as for phase 2.
(b) Band for overlap and special phases as required.
(c) Flashing beacons having separate service do not require banding.
(d) These requirements do not apply to signal cable.
(e) “S” if circuit is switched on line side of service equipment by utility.
(f) Band conductors in each pull box and near ends of termination points. On signal light circuits, a single band may be placed around 2 or 3 ungrounded conductors comprising a phase. NBR is No Band Required.
(g) Ungrounded conductors between service switch and flasher mechanism shall be black and banded.
(h) Conductors between ballasts and sign lighting lamps shall be No. 16 and color shall correspond to the ballast leads.
(i) Both conductors between external high intensity discharge (H.I.D.) ballast and lamp socket shall be black.
(j) Black acceptable for size No. 2 and larger. Tape ends for 450 mm (18 in.) with indicated color.

Conductor insulation shall be of a solid color or of basic colors with a permanent colored stripe as detailed in the above table unless otherwise specified. Solid or basic colors shall be homogeneous through the full depth of insulation. Identification stripes shall be continuous over the entire length of the conductor. For conductor sizes No. 2 and larger, the insulation may be black and the ends of the conductors shall be taped with electrical insulating tape of the required color for a minimum of 450 mm (18 in.).

**623.02.20 Fiber Optic Cable.** Fabricate fiber optic cable, jumper cables, and distribution equipment at a certified ISO 9001 manufacturer. Supply all fiber cable from the same manufacturer utilizing identical specifications. Furnish dielectric fiber cables.

(a) Materials. Use fiber optic cable containing single mode optical fibers, loose tube, filled with a water blocking material, and suitable for installation in underground conduit and field cabinets. Fiber optic cable shall comply with the requirements of RUS 7 CFR Sec. 1755.900 for PE 90.

Design fiber optic cable to achieve a life expectancy of 20 years when installed to manufacturer's specifications.

Contain optical fibers inside a loose buffer tube. Each buffer tube shall contain the number of fibers called for on the plans. The buffer tubes shall allow free movement of the fibers without fiber damage during installation or normal operation, including expansion and contraction of the buffer tubes. Use the same diameter buffer tubes in a cable.

Fill each buffer tube with a non-hygroscopic, non-nutritive to fungus, electrically non-conductive, homogenous gel. Use gel free from dirt and foreign matter and readily removable with conventional nontoxic solvents.

Strand buffer tubes around a central member using the reverse oscillation or "S-Z" stranding process. When less than five buffer tubes are required in the loose tube cable, include filler rods in the cable core to lend symmetry to the cable cross-section. Use filler rods having the same diameter as the buffer tubes.

Design the cable with a central strength member to prevent buckling of the cable.

Fill the cable core interstices with a non-nutritive to fungus, electrically non-conductive, water-blocking material such as water-swellable tape that is dry to the touch. Use water blocking material free of dirt and foreign matter.

Use cables containing at least one ripcord under the sheath for easy sheath removal.

Provide cables having tensile strength members that minimize cable elongation due to installation forces and temperature, and withstand a 2,700 N (607 lb) tensile load applied per EIA- 455-33. The change in attenuation shall not exceed 0.2 dB during loading and 0.1 dB after loading. Provide cables rated for an installed tensile service load of 890 N (200 lb) or more.

The cable jacket shall be dielectric (with no armoring) and consist of either high density (HDPE) or medium density polyethylene (MDPE). Apply the jacketing material directly over the tensile strength members and water-blocking material.

Provide fiber optic cable jacket with markings that include cable length in meters or feet and the year of manufacture. In addition, provide two color stripes, or similar approved marking, for the entire length of each cable to distinguish between trunk, data distribution, and video distribution cables.

Use fiber optic cable capable of withstanding, without damage or decrease in function, cable freezing per EIA/TIA-455-98, total immersion in water with natural mineral and salt contents, salt spray or salt water immersion for extended periods, and wasp and hornet spray.

Furnish cable free from optical splices in one continuous length per reel. Allow a minimum length of 1.8 m (6 ft) on each end of the cable accessible for testing.

Where lengths have been ordered that exceed the reel capacity, provide a minimum of 12 km (7.5 mi) of continuous fiber cable per reel for fiber counts of 36 and less, and 10 km (6.2 mi) of continuous fiber cable for fiber counts greater than 36.

Stencil or letter the factory order number, job number, ship date, manufacturer's cable code, type of cable (single mode, outdoor, indoor), beginning and ending length markings, and measured length and attenuation information on the reel, or provide on a weatherproof tag firmly attached to the reel.

Use ST type Connectors at field cabinet locations and SC type at hub buildings and the STC. The measured attenuation of the connector (inclusive of coupler and mated test connector) shall not exceed an average of 0.3 dB for all connectors provided. Any connector found in excess of 0.5 dB will be rejected. Reflectance shall be less than -40 dB, from –10 °C to 60 °C (14 °F to 140 °F). The manufacturer shall have a program that periodically tests connector to ensure that after 1,000 re-matings, the attenuation will not change more than 0.2 dB.

Use connector capable of withstanding an axial pull of 112 N (25 lb) with no physical damage to the connector and no permanent optical degradation of more than 0.3 dB. Connectors shall be pre-wired by the manufacturer.

Use fiber optic jumper cables complying with NEC requirements for indoor fiber optic cable. Connectors shall be pre-wired by the manufacturer with strain relief. Use jumper cables having an aramid yarn strength member and rugged PVC sheathing. Jumper cables shall comply with the following requirements:

| | |
|---|---|
| Buffering of each fiber, initial | 250 μm (10 mils) |
| Buffering of each fiber, applied after initial | 900 μm (35 mils) |
| Maximum factory measured insertion loss | |
| Subject to EIA/TIA-455-171 | 0.5 dB |
| Subject to EIA/TIA-455-1A, 300 cycles, 0.5 kg | less than 0.2 dB |
| Minimum bend radius, following installation | 320 mm (13 in.) |
| Minimum bend radius, during installation | 640 mm (25 in.) |
| Minimum tensile strength | 444 N (100 lb) |

Use single fiber or duplex jumper cables. Permanently mark duplex jumper cables to distinguish between the fibers or connectors.

Furnish connector modules consisting of a connector panel, couplers, protective housing, and multi-fiber cable that is completely assembled and pre-wired by the manufacturer. The measured attenuation of the connector module (inclusive of coupler, fiber, and mated ST test connector) shall not exceed an average of 0.3 dB for all connector modules provided. Any connector module found in excess of 0.5 dB will be rejected.

Use connector modules complying with NEC requirements for indoor fiber optic cable and the following: 6 couplers for ST applications, 12 couplers for SC applications; 250 μm (10 mils) buffering of each fiber; 900 μm (35 mils) buffering of each fiber applied after the initial 250 μm (10 mils) buffering; provided with prewired, multi-fiber cable of sufficient length to facilitate fusion splicing in a splice tray that is removed from the fiber optic splice unit; having a durable housing that provides physical protection and strain relief for the termination of the multi-fiber cable to couplers; capable of easy installation and removal from the termination housing; and having protective covers for couplers on the jumper cable side.

Maintain a fixed correlation between each buffered fiber color and coupler position for all connector modules. Fiber color shall meet the requirements for outdoor fiber optic cable.

Design splice trays specifically for housing single-mode fusion splices protected by heat-shrink sleeves and which can be easily installed and removed from the fiber optic splice unit. Design splice trays for entry of two, fully jacketed multi-fiber cables from the connector modules, and two buffer tubes from the distribution cable.

Properly size fiber optic splice and termination units for the required number of splices and terminations subject to the minimum requirements stated for each configuration. Provide fiber optic splice and termination units meeting the following requirements: provisions for a minimum of 6 fiber optic cable entries; provisions for internally securing the fiber optic cable sheath and central strength member for a minimum of 6 fiber optic cables; rack mounted; having front and rear doors or removable panels; having a top, bottom, and four sides that fully enclose the interior and protect its contents from physical damage; manufactured using 16 gage aluminum or equivalent and corrosion resistant; provisions for neatly routing cables, buffer tubes, and fan-out tubing; having cable management brackets or rings integral to the unit to secure and route cables from the connector modules and splice trays to the vertical rack members while maintaining a minimum 38 mm (1.5 in.) cable radius.

Furnish fiber optic splice units consisting of a single housing with provisions for installation of multiple splice trays as required. Provide a splice unit having provisions for future installation of two splice trays of minimum 12 splice capacity each, in addition to the required amount. Internal, externally protected feed-through provisions are required for routing of the fiber from the splice unit to the termination unit.

Supply the splice unit with a pull-out shelf that allows easy access to the splice tray, buffer tube and fiber storage area that will permit fusion splicing to be conducted at a minimum distance of 5 m (16 ft) from the housing. Units with hinged shelves are not acceptable. Permanently mark “Communication Fiber Optic Cable Splice Area Inside” on the door or front access panel.

Provide fiber optic termination units consisting of a single housing with provisions for installation of one or more connector modules as required. Configure the termination unit to have a minimum capacity of 24 terminations. Face all connector modules to the front of the rack. Permanently mark “Communication Fiber Optic Cable Termination Area Inside” on the front of the unit.

Furnish integrated fiber optic splice and termination units consisting of a single housing with provisions for connector modules, and splice trays. Provide provisions for a minimum capacity of 24 fusion splices and 24 terminations using splice trays and connector modules. Face connector modules to the front of the rack.

Supply the integrated splice and termination unit with a pull-out shelf that allows easy access to the splice tray, buffer tube and fiber storage area that will permit fusion splicing to be conducted at a minimum distance of 5 m (16 ft) from the housing. Units with hinged shelves are not acceptable. Permanently mark “Communication Fiber Optic Cable Termination and Splice Area Inside” on the door or front access panel.

Design jumper cable troughs to secure, store, and horizontally route jumper cables and other fiber optic cables from vertical frame members on one side of the rack, to vertical frame members on the other side of the rack. Jumper cable troughs shall have a removable front panel, cable rings, and provide physical protection for the jumper cables. Design jumper cable troughs to maintain a minimum 38 mm (1.5 in.) cable bend radius when transitioning from the trough to vertical frame member. The capacity of each cable trough shall exceed the number of jumpers it houses. The total space occupied by each jumper trough shall not exceed two rack units. Match the finish of the jumper cable troughs to the finish of the fiber optic termination equipment.

(b) Installation. Install the fiber optic cable in conduit, field cabinets, hub buildings and the STC as shown in the plans and in accordance with manufacturer’s installation techniques and procedures. Furnish and install all jumper cables and termination equipment that are functionally necessary to connect fiber optic cable to the required end equipment.

Installation of indoor fiber optic cable and jumper cable shall meet the minimum requirements of local building codes and NEC Article 770, inclusive of the Fine Print Notes (FPN). Do not pull the cable along the ground or over or around obstructions. Do not pull optical cable over edges or corners, over or around obstructions or through unnecessary curves or bends. Do not exceed the bend radius criteria of ten times the cable diameter under no stress and twenty times the cable diameter under stress. Use manufacturer approved pulling grips, cable guides, feeders, shoes and bushings to prevent damage to the cable during installation.

When cable is removed from the reel prior to installation, place in a “figure-eight” configuration to prevent kinking or twisting. Take care to relieve pressure on the cable at the crossover by placing cardboard shims, or equivalent method, or by creating additional “figure-eights.”

Before installing fiber optic cable in conduit, provide the cable manufacturer’s recommended and maximum pulling tensions. Include with these pulling tensions, a list of the cable manufacturer’s approved pulling lubricants. Use lubricants in quantities and in accordance with the procedures recommended by the lubricant manufacturer.

When pulling cable by mechanical means, use cable pulling equipment approved by the Engineer and the cable manufacturer. Use cable pulling equipment with a meter to display pulling tension and a mechanism to ensure that the maximum allowable pulling tension is not exceeded at any time during installation.

Furnish attachment hardware, installation guides, and other necessary equipment, not specifically listed herein, as necessary to install the fiber optic cable.

Appropriately loop and tie fiber optic cable to the side wall, in junction boxes.

Coil, label, and tie slack fiber optic cable to cable guides in accordance with the Cable Slack Installation Guide in the plans.

Install optical cable continuous and without splices between allowable splice points as identified on the plans and as specified. Only splice cables in fiber optic splice units or integrated fiber optic splice and termination units that are housed in field cabinets, hub buildings, or the STC. Determine the length of fiber optic cable necessary to reach from splice point to splice point.

Fiber optic plant cable shall enter the rear of the fiber optic splice unit or integrated fiber optic splice and termination unit. Secure the fiber optic cable sheath and central member inside the unit prior to buffer tube fan-out. Plug all entry holes not utilized. Route into, and secure in a splice tray, all buffer tubes with fiber designated for splicing. Secure remaining buffer tubes not accessed within the splice unit.

Route into, and secure in a splice tray, the fully sheathed, multi-fiber cable of each connector module.

When splicing to existing fiber optic cable, prior to procurement of the fiber optic cable, demonstrate that the optical fiber to be supplied can be spliced to the existing optical fiber cable at each location within the acceptable loss requirements as specified herein. This requirement will be waived for any location wherein the Contractor selects optical fiber and cladding of identical manufacturer and part number to that of the existing optical fiber and cable, and furnishes supporting documentation.

Perform splices and terminations in accordance with the cable manufacturer's and the splice equipment manufacturer's recommendations.

Maintain consistency of fiber colors, where possible, during splicing. Do not revise engineering plans and/or splice tables without approval.

Label fiber terminations neatly and permanently on the connector module to designate transmit or receive, when appropriate, with the string number. Label spare fibers as "spare" with string number.

Install blank connector panels, of same finish and manufacture as the connector modules, for all unused connector module spaces.

Provide and maintain protective covers over the optical connectors and termination until jumper cables are installed. Protective covers on terminations not used shall remain.

For mid-cable access, only fibers within a buffer tube that are designated for splicing shall be individually accessed, spliced to the appropriate fibers from the connector module(s), and secured neatly within the splice tray. Secure the remaining fibers in the buffer tube, that are not designated for splicing, neatly within the splice tray and do not cut. Accomplish removal of the buffer tube to access the fibers using equipment specifically designed for buffer tube removal without damaging the individual coated fibers.

Accomplish full-cable splices by splicing all fibers, including spares, together to provide continuous runs or splice to the appropriate fibers from the connector module(s). Secure fibers neatly within the splice trays.

For full-cable termination, splice all fibers, including spares, to the appropriate fibers from the connector modules, and secure neatly within the splice tray.

Accomplish fiber-to-fiber splices by means of the fusion splice technique without inducing more than 0.1 dB attenuation for each splice and 0.07 dB average for all splices. Re-splice, at own expense, splices found to exceed 0.1 dB attenuation as many times as necessary to meet this dB requirement.

Package each splice in a protective sleeve or housing and secure in splice trays located in the fiber optic splice unit or integrated fiber optic splice and termination unit. Completely re-coat bare fibers with a protective heatshrink coating prior to placement in a sleeve or housing. Install the heat-shrink coating in such a manner as to protect the fiber from scoring, dirt accumulation, moisture intrusion, and microbending.

Accomplish termination of distribution and trunk fiber by splicing the distribution or trunk fiber to the appropriate fiber from a connector module. Field termination of fibers to connectors will not be permitted.

Measured attenuation at each termination, inclusive of two connectors and coupler, shall not exceed 0.5 dB.

Install jumper cables from the connector module to end equipment, and from end equipment to end equipment in multiple cabinet configurations. Secure jumper cables to provide strain relief at both the connector module and the end equipment. Adhere to the manufacturer's recommended installation and minimum bend radius requirements.

Fiber optic splice and termination unit configurations vary depending on whether the plans call for a midcable access, full-cable splice, or full-cable termination.

Equip mid-cable access locations with an integrated fiber optic splice and termination unit. Install one connector module with six ST terminations at CCTV locations. Install two connector modules with minimum four ST terminations each at VMS, detector, or combination VMS and detector locations. Install one connector module with six ST terminations at combination CCTV and VMS, CCTV and detector, or CCTV, VMS and detector locations. Install two connector modules with minimum four ST terminations at each VMS and/or detector location.

Equip full-cable splice locations with either an integrated fiber optic splice and termination unit, or a combination of a fiber optic splice unit and a fiber optic termination unit. Install connector modules as specified above for mid-cable access locations.

Equip full-cable termination locations with either integrated fiber optic splice and termination units or a combination of a fiber optic splice units and fiber optic termination units. House all fiber optic distribution in a single fiber distribution rack at the STC and each hub building. Use connector modules with twelve SC couplers per module at the STC and hub buildings. Use connector modules having six ST couplers per module at field cabinets. Install a minimum of three jumper cable troughs in each new hub building fiber distribution rack. Position jumper cable troughs at the bottom, middle, and top of the rack.

(c) Testing. Use fiber optic cable and distribution equipment meeting the design approval certification and factory acceptance, pre-installation and post-installation test requirements specified herein.

Submit design approval certification documentation for all required factory testing. Submittal of RUS certification will satisfy this requirement for the tests that are required by RUS 1755.900.

Factory test fiber optic cable, connector modules and fiber optic jumper cables to demonstrate compliance with the requirements specified herein.

For pre-installation testing, test outdoor and indoor fiber optic cable using an optical time domain reflectometer (OTDR) or power meter prior to installation to demonstrate continuity of each fiber. This test shall include visual inspection for damage to the cable jacket prior to installation. Do not install cable that does not meet specifications, or exhibits visual damage to the cable jacket.

Prior to splicing new to existing fibers, conduct a bi-direction OTDR or power meter test for each existing fiber string to be used as specified. Give notification of any existing strings that exhibit attenuation loss that, when added to the full link, would result in total loss in excess of the budgeted loss. Re-test any fibers exhibiting unacceptable losses using the bi-directional OTDR test. Perform additional OTDR tests on existing unassigned fibers, as necessary, to find a suitable alternative when directed.

For post-installation testing, test fiber optic cable systems in conformance with the procedures of TIA/EIA-526-7A. Testing of spare fiber is required. Submittal of test data shall include a summary sheet that clearly illustrates measured loss versus budgeted loss. On the summary sheet, identify each fiber by cable, number, and color. Identify any unacceptable losses and make corrective actions. Failed splices may be remade and retested for compliance. Replace in its entirety and re-test for compliance, any cable that is found not compliant to the specifications. Place one copy of the final post-installation test results in a protective sleeve and attach to the rack or door as directed.

Perform the following post-installation tests:

1. Conduct power meter tests for each individual fiber strand from the field cabinet to the hub buildings, between the STC and each hub building, and between hub buildings, to demonstrate connectivity in accordance with the specifications.

2. Conduct bi-directional (OTDR) tests for each individual fiber strand installed from the field cabinet to the hub building, between hub buildings, and from each hub building to the STC, to demonstrate that the attenuation for each installed fiber, termination, and splice, and the link as a whole, complies with the loss budgets as required. Submit OTDR traces. Clearly annotate each event (connector module, jumper cable, splice, etc.) with the measured loss identified.

**623.02.21 Wiring.** Install wiring according to the regulations and code listed in Subsection 623.01.03 and the additional requirements of this Subsection.

(a) Signal Circuitry. Provide 25 conductor No. 14 cable for all signal installations, except for 1-A and 1-B poles. For 1-A and 1-B poles, determine the number of conductors required for pedestrian detectors, pedestrian heads, and signal heads and provide a No. 14 cable with a minimum of three spare conductors in multiples of five (15 conductor minimum).

Run all signal light conductors, except branch neutrals, continuously without splices from a terminal block located in a cabinet to a similarly located terminal block in the poles or signal head brackets. Provide each pole with its own home run cable.

Provide connection to each terminal of a pedestrian push button by a single conductor.

Make the neutral for pedestrian push button circuits separate from the signal light circuit neutral.

(b) Installation. Use a UL or ETL approved inert lubricant in placing conductors in conduit.

Pull conductors into conduit by hand. Do not use winches or other power actuated pulling equipment.

When new conductors are to be added to existing conductors in a conduit, remove all conductors. Clean the conduit with a mandrel or cylindrical wire brush and blow out with compressed air. Pull both old and new conductors into the conduit as a unit. If permitted, new conductors may be pulled through conduit with existing conductors in place, when conditions are suitable and damage will not occur to the new or existing conductors.

Enclose temporary conductors less than 3 m (10 ft) above grade in flexible or rigid metal conduit.

Leave at least 600 mm (2 ft) of slack for each conductor at each signal or lighting standard, or combined standard, and at least 1.5 m (5 ft) of slack at each pull box.

Leave at least 1.5 m (5 ft) of slack for each conductor at each splice.

Tape ends of spare conductors to provide a watertight seal.

Tie conductors within fixtures or cabinets together with self-clinching nylon cable ties or other approved method.

Neatly arrange and lace wiring within controller cabinets, or enclose in plastic tubing or raceway.

Mark small permanent identification bands as detailed in the conductor table in Subsection 623.02.19. Securely attach the bands to each conductor in each pull box and near the end of each conductor where conductors are terminated. Where circuit and phase are clearly indicated by conductor insulation, bands need not be used. Use permanent identification bands of embossed aluminum foil tape with pressure-sensitive, oil resistant backing. Tape shall be of a type such that embossed symbols contrast with the background color.

(c) Connectors and Terminals. Join conductors by the use of connectors or other methods permitted. Solder splices, with or without connectors by the pouring or dipping method, except that soldering of pressure connectors and terminals may be omitted provided the connectors and terminals are applied with the proper type tool as recommended by the manufacturer of the connector or terminal being applied. Do not open flame solder. Finished connections and terminals shall comply with MIL-T7928. The only solder allowed shall be a 60/40 rosin core solder suitable for electronic circuits. Do not use acid core solder.

Terminate stranded conductors smaller than No. 14 in crimp style terminal lugs.

(d) Splicing. Unless specified otherwise or permitted, splices will be permitted only in the following types of circuits at the following locations:

1. Branch signal light neutrals in pull boxes.

2. Pedestrian push button circuits in pull boxes.

3. Multiple lighting conductors in bases of standards or in pull boxes.

4. In temporary modifications to traffic signal systems where shown on the plans.

Do not pull splices into conduits or other locations not readily or easily accessible to visual inspections.

Do not splice conductors in controller cabinets and interconnect cable. Unless indicated, do not splice signal cable.

In lieu of the 600 V or the 5,000 V splice and splice insulation shown on the plans, a pin and receptacle connector may be used.

Use a pin and receptacle, locking type connector, with waterproof housing, capable of being disconnected without damage. Use a pin of medium hard copper material with the portion to be crimped onto the conductor fully annealed. The receptacle shall be of copper material fully annealed. Size the pin and receptacle to provide not less than 90% ampacity of the conductor being spliced. Apply the pin and receptacle to the conductor using a tool as recommended by the connector manufacturer. Soldering will not be required. The pin and receptacle shall have centrally located, recessed locking areas, which shall match complementary areas of the housing.

The receptacle shall establish contact pressure with the pin through the use of a copper beryllium sleeve spring and the receptacle and pin shall lock together so that the connection will be maintained when a minimum force of 89 N (20 lb) tension pull is applied to the attached conductors.

Provide separate housings for the pin and the receptacle. Make each housing of water resisting synthetic rubber suitable for direct burial in the ground or installation in direct sunlight. Each housing shall have an interior arrangement, complementary to the pin and receptacle, suitable to receive and securely retain the pin and receptacle, also a section to form a water-seal between the housings at the point of disconnection. Provide a small slot or vent along the housings to permit the exclusion of air. Place sufficient silicon type insulating compound to fill all the voids in the assembly in the housings before installing the pin and receptacle.

In lieu of the 600 V splice and splice insulation shown on the plans, an epoxy insulated spring connector applied as specified herein may be used.

Join the ends of the wires together with an insulated spring type connector without soldering.

Furnish a two component, self-curing, epoxy resin in a double compartment, plastic envelope. Make the splice insulation by thoroughly mixing the two components in the envelope and, after cutting open one end of the envelope, inserting the wire-connection into the epoxy resin and then taping shut the open end of the envelope.

Other approved methods may be used to mix and apply epoxy resin.

Provide sufficient epoxy resin to completely cover the connector and exposed bare wires at connector. The container shall be transparent to allow inspection.

(e) Splice Insulation. Splice insulation shall conform to the details shown on the plans, provide a moisture/weatherproof seal, be capable of sustaining temperatures of 75 °C (167 °F) without thermal breakdown, and have an insulation integrity equal or greater than the joined conductor insulation.

Use low-voltage tape UL approved of either of the following types:

1. Self-fusing, oil and flame-resistant, synthetic rubber.

2. Pressure-sensitive, adhesive, polyvinyl chloride, 0.18 mm (0.007 in.) minimum thickness.

Insulate splices in low-voltage circuits (600 V maximum) by “Method A” as shown on the plans with either of the low-voltage type tapes. Insulate splices made by “Method B” shown on the plans with both types of low-voltage tape.

Insulate splices in high-voltage (over 600 V) circuits with tape resistant to ozone, corona and water. High-voltage tape shall be self-fusing, vegetable oil base, natural rubber.

Where polyvinyl chloride tape is used for a final layer, use an electrical insulating coating which is fast drying, resistant to oil, acids, alkalies, and corrosive atmospheric conditions and is compatible with the tape.

Where more than one conductor enters a ballast sleeve, apply the insulation and taping between the conductors in such a manner as to provide a watertight joint. Make the splice capable of satisfactory operation under continuous submersion in water.

On 600 V and 5,000 V conductor splices, a cast insulation of self-curing epoxy resin, may be used, which is compatible with wire insulation to form a moisture resistant joint. The resin shall be resistant to weather and aromatic and straight chain solvents and, in addition, shall not sustain combustion. Pour the resin into molds of dimensions suitable for the splice.

On 600 V maximum circuits, either of the following splice insulation methods may be used:

1. Method A. A minimum of thicknesses of electrical insulating pad, composed of a laminate of 2 mm (0.085 in.) thickness of electrical grade polyvinyl chloride and a 3 mm (0.125 in.) thickness of butyl splicing compound with removable liner. Apply pads to the splice according to the manufacturer's recommendations. Wrap the ends of the applied pad with polyvinyl chloride tape half lapped over the conductor insulation.

2. Method B. Apply heat shrinkable insulating tubing after completing the splicing procedure shown on the plans. Use insulation over the connector consisting of a heat shrinkable, mastic lined, heavy wall polyolefin cable sleeve or cover. Apply heat at a temperature greater than 120 °C (248 °F) until the sleeve, or cover, shrinks and covers the connector and the mastic material has flowed completely around the cable to form a waterproof insulation.

On 5,000 V conductors, splices may be waterproofed by using heat shrinkable, mastic lined, heavy wall polyolefin cable sleeve, or cover. Apply heat at a temperature greater than 120 °C (248 °F) until the sleeve, or cover, shrinks and covers the connector and the mastic material has flowed completely around the cable to form a waterproof insulation in lieu of the final application of two layers of polyvinyl chloride tape, after being insulated as shown on the plans.

(f) Fused Splice Connectors. In each pull box adjacent to an electrolier or in base of pole, install a fused disconnect splice connector in each ungrounded conductor between the line and the ballast. Make the connector readily accessible in the pull box or in the base of the pole.

For 240 V and 480 V circuits, design each connector so that both ungrounded conductors are disconnected simultaneously. Make the connector with no exposed metal parts.

The splice connector shall completely enclose the fuse and shall protect the fuse against damage from water and weather. The contact between the fuse and fuse holder shall be by spring pressure. Springs shall not be a part of the current carrying circuit. Rigidly crimp the terminals of the splice connector using a tool of the type recommended by the manufacturer of the fused splice connector, on to the line conductors and the conductors to the ballasts and insulate and make waterproof according to the splice connector manufacturer's recommendations.

Do not use fused splice connectors in series circuits.

Use standard midget, ferrule type fuses.

**623.02.22 Bonding and Grounding.** Make metallic cable sheaths, metal pull box covers, metal conduit, nonmetallic conduit grounding wire, ballast and transformer cases, service equipment, sign switches, anchor bolts, and metal poles and pedestals mechanically and electrically secure to form a continuous system, and effectively ground.

Use bonding and grounding jumpers of copper wire or copper braid (aluminum is not allowed) of the same cross sectional area as No. 6 minimum for systems not exceeding 200 A overcurrent protection, and No. 8 minimum for systems not exceeding 100 A overcurrent protection (See NEC Article 250, Table 250-95). Color code equipment grounding conductors to NEC requirements or supply bare.

Provide bonding of standards and pedestals by means of a bonding wire or braid attached from the bonding lug to a bonding plate set at the bottom of the pedestal. Attach the bonding wire to the anchor bolt or reinforcing cage with a 4.5 mm (3/16 in.), or larger, brass or bronze bolt installed near the mid portion of the shaft. The bonding plate shall not be less than 190 mm (7 1/2 in.) in diameter and shall be made of nonferrous metal.

Where slip base standards or slip base inserts are installed, do not intrude the grounding jumper into the slip plane. Accomplish bonding by a bonding strap to the anchor bolts or a 4.5 mm (3/16 in.) or larger brass bolt installed in the bottom slip base plate.

Ground one side of the secondary circuit of series-multiple and step down transformers.

Ground metal conduit and service equipment as per NEC Article 250. Ground the neutral conductor secondary at the service point only and as required by the NEC, together with the requirements of the serving utility. Use minimum No. 6 service grounding conductor.

For bonding purposes in all nonmetallic type conduit, run a bare No. 6 (minimum) copper conductor continuously in conduits with circuits not exceeding 200 A and a bare No. 8 (minimum) copper conductor continuously in all other circuits, not exceeding 100 A.

Where nonmetallic conduit is to be installed for future conductors, the above mentioned copper wire may be omitted.

Equipment bonding and grounding conductors are not required in conduits which contain only loop lead-in cable or signal interconnect or both.

At each multiple service point, furnish and install a ground electrode meeting the requirements of NEC Article 250-83 and the requirements of the serving utility. The minimum allowed ground electrode made of steel or iron, shall consist of a single length of galvanized rod or pipe with 2.5 m (8 ft) of length in contact with the soil, and have a diameter of at least 20 mm (3/4 in.). The minimum allowed non-ferrous ground electrode shall have at least 2.5 m (8 ft) in contact with the soil and be at least 15 mm (0.5 in.) in diameter. Bond the service equipment to the ground electrode by use of a ground clamp and a copper conductor not smaller than No. 6, enclosed in a 15 mm (1/2 in.) diameter conduit.

Where a metal conduit system parallels, or crosses, a permanent water system in accessible areas, install grounding jumpers at intervals not exceeding 150 m (500 ft).

Ground clamps for service grounding and for grounding of equipment on wood poles shall be a 15 mm (1/2 in.) galvanized, malleable iron conduit hub with swivel feature.

On wood poles, ground all equipment mounted less than 3 m (10 ft) above ground surface.

Bond metallic conduit in concrete pull boxes by means of galvanized grounding bushings and bonding jumpers.

Bond metallic conduit in steel pull boxes by means of locknuts, one inside and one outside of the box.

## CONTROLLERS

**623.02.23 Controllers.** Furnish and install controllers as a complete integrated assembly.

In addition to complying with the requirements herein, controllers shall also meet the requirements of the maintaining agency.

For the purposes of this section, all conflict monitors (malfunction management units), bus interface units, cabinet power supplies, detector amplifiers, central video processors, modems (LCIU's), load switches, flasher units, fans, foundation and all auxiliary support equipment mounted and wired into the cabinet are considered to be included as part of the controller.

Identify equipment inputs, outputs and terminals by the phase designations shown on the plans.

The manufacturer shall certify, in writing, that upon delivery, each controller is in proper working order as required to operate the intersection or ramp meter as specified herein, in the Special Provisions and in the plans.

Provide traffic controller and assembly equipment conforming to the requirements of the most current edition of NEMA Standards Publication No. TS 1.

When specified, provide Model 170E Controller and assembly equipment conforming to the requirements of "Transportation Electrical Equipment Specifications" (TEES) and "Traffic Signal Control Equipment Specifications" (TSCES), issued by the State of California, Department of Transportation and to all addendums thereto current at the time the contract is bid.

When specified, provide Model 2070N Controllers conforming to the requirements of "Transportation Electrical Equipment Specifications" (TEES) and "Traffic Signal Control Equipment Specifications" (TSCES), issued by the State of California, Department of Transportation and to all addendums thereto current at the time the contract is bid.

**623.02.24 Cabinets.** Following are the minimum requirements for traffic signal controller cabinets used to house traffic controllers, auxiliary accessories, and other traffic control devices.

NEMA—2070N. Provide documentation indicating the furnished unit meets all requirements specified herein.

Provide controller cabinets meeting the requirements of ITE "Equipment and Material Standards," Chapter 8 with the additional and auxiliary equipment specified herein.

House each traffic actuated controller unit and auxiliary equipment in a weatherproof aluminum, steel, or other approved metal cabinet, as shown on the plans and as described herein.

All overlapping seems for metal cabinets shall meet the requirements for Type 4 enclosures according to NEMA Standards Publication 250.

(a) General Requirements. Provide all cabinets as a complete unit to include all shelves, foundations, anchor bolts with template, locks, door stops, etc., and to be completely painted as specified in Subsection 623.02.07.

Provide weatherproof cabinets properly ventilated, and with a vent fan as specified herein.

Doors shall be hinged on the right side of the cabinet as viewed from the outside facing the cabinet door opening. Make cabinets with each and every door mounted with hinges welded to door and jamb.

Each cabinet must fit the anchor bolt pattern as specified on the standard drawings. Modification of cabinet base to fit a non-standard anchor bolt pattern will not be permitted without approval.

Make cabinet wiring neat and firm and lace or bind all harnesses and cabinet wiring together with TY-WRAP or equivalent.

Number and identify terminals according to the cabinet wiring diagram.

Furnish wiring diagram prints for each cabinet, reproduced from a reproducible drawing provided by the manufacturer, pursuant to Subsection 623.01.04. Equip the cabinet with a plastic envelope to house one or more cabinet wiring diagrams.

The cabinet wiring diagram shall show and identify the connectors for all equipment and switches, relays, flashers, and signal control bases. The cabinet wiring diagram shall also have an intersection sketch with heads, detectors, and pushbuttons identified and a Signal Sequence Chart identified and related to the intersection sketch.

Furnish mechanical relays with clear covers.

Furnish the following terminals, wiring, and switches for all cabinets:

1. A single pole circuit breaker, plug-in type, for control of all power to the controller and its auxiliary equipment. Provide a terminal, unfused, for neutral side of the power supply line.

2. Terminal blocks for connection of traffic and pedestrian signal light field wires not specified for flashing operation.

3. Terminal blocks for connection of traffic and pedestrian signal light field wires specified for flashing operation.

4. Terminal blocks for connection of detector amplifiers, detectors, and pedestrian pushbutton field wires.

5. Copper ground strip, mounted and grounded to cabinet wall, for connection of all common conductors.

6. Terminal blocks for connecting cable tie points and intercabinet terminations. Also a terminal block or terminal blocks (depending on intersection requirements) for terminating the traffic computer system interconnect cable. For this block or blocks use telephone type Reliable Electric #R66B4-25 or equivalent.

7. A two circuit solid state jack mounted flasher, having a minimum flashing rate of 50 to 60 flashes per minute. Wire the flasher circuits in the cabinet according to the standard auxiliary cabinet equipment wiring drawing.

8. Convenience Outlet and Voice Communication Phone Jacks:

    a. Furnish a duplex “u” ground type of convenience outlet for test equipment, tools, and lighting. Provide outlet with an integral ground fault protection device.

    b. Furnish 2 phone jacks, identified as “TMC” and “JMC,” wired to the interconnect terminal block. (In Las Vegas area only. One phone jack in all other areas unless otherwise indicated on the plans.)

9. Switches Behind Police Auxiliary Door: “Auto-flash” switch, identified “auto-flash,” wired to de-energize signal light power and place signals on “flash,” but to keep controller power energized during the flash period. When the “auto-flash” switch is placed in the “flash” position, the stop-time device required within paragraph (c) “Conflict Monitor,” shall be activated to store and display the indication that the “auto-flash” switch was triggered.

10. Interior Cabinet Switches:

    a. A “Main switch,” identified “on-off,” wired to de-energize both controller and signal light power when switched to “off” position.

    b. A “Test switch” three position switch (or equivalent) identified “auto-off-flash,” wired to de-energize controller power during “off” and “flash” positions.

    c. The test switch, main switch, voice communication phone jacks, and convenience outlet may be combined on a single panel and preferably mounted on cabinet door behind the police auxiliary panel.

11. Radio line filter or filters for filtering AC + lights and control power for solid state light control and controller operation.

12. Thyrector or gas filled surge protector for filtering lightning or high voltage surges to ground for protection of solid state components.

(b) Additional Cabinet Equipment. Provide all cabinets, unless otherwise specified, with a top mounted fan.

Provide each Type G cabinet with a top mounted fan only when specified on the traffic signal drawings or in the Special Provisions. Ventilate each Type G cabinet if a fan is not a requirement.

Provide Type M-1 and Type R cabinets with a fluorescent fixture and light mounted in the cabinet interior, preferably over the door, at a location least likely to be damaged. The length shall be determined by the cabinet width. Provide the fixture with an on-off switch operated automatically with light on when door is opened and off when the door is closed.

Equip each cabinet with a vehicle and pedestrian detector test panel located on the inside of the cabinet door, equipped with toggle switches and pushbuttons, wired for permitting the introduction of manual calls into each controller vehicle or pedestrian detector input. The toggle switch, in one position, shall permit calls into the controller for vehicle and pedestrian detectors. The toggle switch, in one position, shall disconnect the vehicle and pedestrian detectors and permit calls into the controller via manual push button actuation. Provide each vehicle and pedestrian detector circuit with a separate toggle switch and manual push button. Provide toggle switches and push buttons for all future phases and wire to the terminal blocks.

Equip Type M-1 cabinets with a hook type door stop. Make the hook end at least 40 mm (1.5 in.) long. For Type R cabinets, locate a door stop device at the top or bottom of the door that will allow securely fastening the door opened to 90 and 180 degrees.

Install a conflict monitor (malfunction management unit) as hereinafter described in each traffic signal cabinet.

Install load switches as hereinafter described in each traffic signal cabinet.

Provide necessary cabinet wiring, connecting cables, and support bases for all future vehicle and pedestrian phasing possible for each specific controller. Provide phase overlaps when specified on the traffic signal drawings. Provide a load switch with each support base for future operation. The cabinet wiring diagram shall include clear instructions for expansion to the additional phases and all wiring to be changed or removed shall be tabulated. It shall not be necessary to add wiring to expand phases.

Furnish a local communications interface panel. This panel and its purpose is described in Subsection 623.02.25.

Provide terminal blocks for connection of a minimum of 16 loop amplifier connecting cables (160 terminals) in each “Type R” cabinet. Provide additional terminal blocks for loop amplifier connecting cables required for local traffic computer systems and counter detectors. The number of additional loop amplifier connecting cables required shall be specified on the traffic signal drawings or in the Special Provisions.

(c) Conflict Monitor (Malfunction Management Unit). Make the conflict monitor a self-contained solid state device capable of detecting conflicting signal displays and/or improper power supply voltage from the controller.

The unit shall monitor for conflicting indications during the green, amber, and walk of each phase and be programmable to designate the conflicting phases. The unit shall also monitor all red signal sections on each approach of each phase; a conflict shall be indicated if all red signal lamps on any single approach are dark. All monitoring shall be done on the field side of the cabinet wiring terminals.

When the monitor is triggered as a result of sensing conflicting indications or the “auto-flash” switch is switched to “flash,” have the monitor place the intersection into emergency flash, stop time the controller, and store and display the conflicting indications experienced at the moment of the conflict on the front of the unit. The monitor shall retain this operation until reset by a front panel pushbutton.

When the monitor is triggered as a result of sensing a supply voltage error, have the monitor place the intersection into emergency flash and retain this operation until reset by the front panel pushbutton or restoration of proper power.

The sensitivity of the threshold level shall be 25 ± 5 VAC. Voltage levels above 30 VAC shall be sensed while voltages below 20 VAC shall not be sensed. The monitor shall not trigger until the conflict has been sensed for more than 100 ms.

Wire the monitor for eight vehicle and four pedestrian phases.

Make the monitor capable of outputting a ground true signal when in a conflicted condition. Wire this output to the communication interface panel terminal.

Provide a conflict monitor meeting the requirements of NEMA Standards Publication No. TS 2, Section 4.

(d) Load Switches. Accomplish the interface between the controller and the vehicle and pedestrian signals through solid state load packs. Each load pack shall have three solid state switches in a modular assembly for opening and closing the connection between applied power and the traffic signals.

Provide load switches conforming, in its entirety, to the current NEMA Standards Publication No. TS 2, Section 6.

**623.02.25 Local Traffic Computer System Coordination Equipment.** Use local computerized traffic control system requirements specified in the Special Provisions.

**623.02.26 Time Base Coordination Unit.** Provide the unit for coordination of signalized intersections without the use of the interconnect cable. Use the latest technology solid state circuitry as specified in the Special Provisions in the coordination unit.

**623.02.27 Pre-Timed Controller Units.** Controller unit requirements shall be specified in the Special Provisions.

Only use pre-timed controller units when directed.

DETECTORS

**623.02.28 Video Image Detection System.** Provide in each system complete intersection detection, automatic incident detection, freeway detection/management, freeway ramp control, vehicle counting/classification, collection of traffic statistics, turning movement analysis, wrong-way detection, queue length analysis, and critical incidents in real-time for traffic management.

(a) General. The video image detection system shall provide flexible detection zone placement anywhere and at any orientation within the combined field of view of the cameras. Preferred presence detector configurations shall be lines placed across lanes of traffic or lines placed in-line with lanes of traffic. A single detector line shall be able to replace multiple conventional detector loops connected in series. Detection zones shall be able to be overlapped and shall also have the capability of implementing logical functions, including AND, OR, NAND, N or M and delay/extend timing.

In addition, the video image detection system shall be capable of removing shadows, such that vehicles casting shadows into adjacent lanes during daylight hours or casting headlight glare into adjacent lanes during the nighttime hours do not “Trigger” video loops in any adjacent lanes. The system shall also be capable of Wrong direction detection, such that vehicles traveling in the departing direction from the intersection do not “Trigger” video loops configured for the approaching direction, and image stabilization, such that vehicle detection does not fail during windy conditions.

The detection zone shall be located and placed by means of a field programming unit. The system shall be capable of showing images of the detection zones superimposed on the video image of traffic.

Supply a power unit having capabilities for 115 VAC, 60 Hz and 230 VAC, 50 Hz.

Install a separate power outlet for the video detection. Do not use the GFI service outlet in the cabinet. Do not plug other controller cabinet equipment into the GFI service outlet.

Terminate the power cables for the video cameras on a terminal strip with the appropriate connection being made to the power bus.

Place video equipment on a shelf and in a secure fashion. Do not stack equipment.

Splice the power cable according to the splicing detail on Standard Plan Sheet T-30.1.16 or by another approved method.

Connect the coaxial cable via a “BNC” and barrel connection, and make waterproof.

Serial communications for the processing unit shall be a 9 pin male D connection, RS232/422 together with a 15 pin female connection, NEMA TS2 (SDLC).

The processing unit shall have 32 detection outputs utilizing a 37 pin female D connector. The detection outputs shall be of the open collector or open emitter type. The detection outputs shall be of the open or closed type for vehicle detection.

When a vehicle is under a detection zone, the detection zone shall change in color or intensity on the monitor, thereby verifying proper operation of the detection system. Color changes may also be used to indicate detection delay and extension timing.

The video detection system shall reliably detect vehicle presence when the camera is mounted 10 m (30 ft) or higher above the roadway, when the camera is adjacent to the desired coverage area, and when the length of the detection area or field of view is not greater than 10 times the mounting height of the camera. The camera shall not be required to be mounted directly over the roadway. A single camera, placed at the proper mounting location with the proper lens, shall be able to monitor all through travel lanes and turning movements simultaneously.

All system hardware components shall be warranted by the supplier for a minimum period of 2 years, starting after the system has been accepted.

Overall performance of the video detection system shall be comparable to inductive loops. Using standard camera optics and in the absence of occlusion, the system shall be able to detect vehicle presence with 98% accuracy under normal conditions (day and night) and 96% accuracy under adverse conditions (fog, rain, snow).

(b) Equipment. Provide a Central Video Processor (CVP) including all necessary cables, harnesses, materials, fittings, field programming unit and all field assistance during installation, software, training during installation, follow-up training and technical support after installation, and any miscellaneous components detailed in the contract necessary to provide a complete and operating video detection system at signalized intersections, ramp meters, and ITS VID stations.

Provide cameras with variable focal length and capable of motorized zoom to optimize performance.

Provide a field programming unit system, when specified in the plans, equipped with a modern and portable printer as needed for set-up and viewing of vehicle detections.

Furnish video power and coaxial cable that is compatible with and makes the system complete and operating.

(c) Central Video Processor (CVP). Furnish a CVP system capable of detecting vehicles in multiple traffic lanes. A minimum of 100 detection zones shall be user-definable through interactive graphics by placing lines and/or boxes in an image on a video monitor. The user shall be able to redefine previously defined detection zones. The CVP shall calculate traffic parameters in real-time and provide local non-volatile data storage for later downloading.

The CVP system shall be capable of simultaneously processing information from a minimum of 4 asynchronous video sources or as specified on the plans. The video sources may be, but are not required to be, synchronized or line locked. The video shall be digitized and analyzed at a rate of 30 times per second.

Provide a CVP system capable of detecting the presence of vehicles in a minimum of 100 detection zones within the combined field of view of the cameras.

Different detector types shall be selectable via software. Detector types shall include count detectors, presence detectors, directional presence detectors, speed detectors, station detectors, input detectors, and detector logical functions. The speed detectors shall report vehicle classification based on length. Three length categories shall be user-definable in software.

Once the CVP system has been properly set up using the field programming unit, it shall be possible to disconnect the unit. The CVP shall then detect vehicles as a stand-alone unit, calculate traffic parameters in real-time, and store traffic parameters in its own non-volatile memory.

The duration of time intervals (or time slices) shall be user-selectable as 10, 20 and 30 seconds, and 1, 5, 10, 15, 30, or 60 minutes.

The time interval data shall be retained in non-volatile EEPROM flash memory with the CVP for later uploading to the field programming unit for analysis.

Retrieval of data stored in the non-volatile memory of the CVP shall be via a serial communications port. Provide provisions for downloading of data via a modem and dial-up telephone lines, via private cable or fiber optic network, and via direct connection to another computer by cable.

The CVP shall include the capability to capture a video image (snapshot) from a selected image sensor input and transmit the image to the field programming unit for display. Compress the captured video image to minimize the time needed to transmit the image. Provide an option to allow continuing or suspending detection while the video image is being compressed and transmitted.

Furnish a shelf or rack mountable CVP capable of fitting in a conventional traffic signal controller cabinet.

Design the CVP to operate reliably in the adverse environment found in the typical roadside traffic signal controller cabinet and to meet the environmental requirements set forth by the National Electrical Manufacturers Association TS 1 and TS 2 specifications, as well as the environmental requirements for Type 170 and Type 179 controllers. Operating temperature shall be from –35 °C (–31 °F) to 74 °C (165 °F) at 0% to 95% relative humidity, non-condensing.

Use gold-plated DIN bus connectors to interconnect the modules of the CVP.

Power the CVP by 89 to 135 VAC, 60 Hz single phase, or by 190 to 270 VAC, 50 Hz, single phase. The power supply shall automatically adapt to the input power level. Surge ratings shall be as set forth in the NEMA TS 1 and TS 2 specifications.

NEMA red/green inputs for up to 16 phases shall provide controller state information for detection and Extend/Delay timing functions. Use an approved connector on the front of the CVP for these NEMA inputs.

Equip the CVP with a minimum of four RS-170 (B&W)/NTSC (color) composite video inputs, so that signals from four cameras or other synchronous or non-synchronous video sources can be processed in real-time.

(d) Camera Requirements. The video cameras used for detection shall produce a useable video image of vehicles under all roadway lighting and environmental conditions, regardless of time of day. Images shall be produced through a CCD (charge coupled device) sensing element. Each camera shall have a field adjustable focal length and aperture to adjust to the specific site requirements. The camera shall be adjustable in the field via a handheld controller or other approved method.

House the camera in a NEMA 4 water-resistant, dust-proof enclosure with provisions to prevent moisture condensation inside the enclosure. The camera shall operate satisfactorily in a temperature range from –35 °C (–31 °F) to 74 °C (165 °F) and a humidity range from 0% to 95% relative humidity. Include lightning protection as part of the camera assembly. Equip the camera enclosure with weather-tight connectors at the rear or bottom of the enclosure for power, video, and adjustment cables.

Supply cameras which have been tested and proven to be fully functional with the CVP and camera mounting hardware. The minimum power, adjustment and video cable lengths furnished with the camera shall be sized to fit the site requirements to run continuously from the camera to the CVP plus 3 m (10 ft) of slack. Provide cables suitable for outdoor installation with direct exposure to the sun.

Mount the camera on the mast arm or the luminaire arm. The exact position, height, orientation, and rotation of the mounting device shall be specified by the system supplier.

(e) Field Programming Unit System. When called for in the contract, provide a field programming unit system equipped with a modern and portable printer as needed for set-up and viewing of vehicle detections. The equipment manufacturer shall contact the Department's Traffic Signal Design Engineer for approval prior to bidding. This unit shall be considered incidental to Video Image Detection System.

The field programming unit shall be capable of driving an external current industry standard monitor, shall be capable of both battery and AC operation, and shall include required batteries, chargers, protective carrying case, including a portable ink jet printer, and system software.

(f) Video Coaxial and Power Cable. The video coaxial cable shall have a tined copper double braid shield, with 98% shielding. Provide polyethylene insulation. Use Belden 8281, West Penn P806, or approved equivalent. Furnish BNC plug connectors at both ends of the cable for connection to the camera and to the CVP. Provide video power cable as shown on the plans.

**623.02.29 Emergency Vehicle Optical Detector System.** The system shall employ optical communication to identify the presence of designated priority vehicles and cause the traffic signal controller to advance or hold a desired traffic signal display selected from phases normally available. Use emergency vehicle detectors listed in the QPL.

(a) General. Make up the Emergency Vehicle Optical Detector (EVOD) system from a matched set of components that will manipulate the existing traffic controller upon recognition of a signal from a designated priority vehicle.

This communication shall be effective to the optical detectors at or near the intersection over a line-of-sight path of at least 700 m (2,300 ft).

Design the system to operate on a first-come, first-served basis or on a selected priority basis and to yield to other priority demands such as railroad crossings.

Make the system capable of interfacing with existing traffic signal controllers without compromising normal operation or existing safety provisions. Compose the system from an optical emitter assembly, optical detectors, optical detector cable, and phase selector assemblies.

Use matched system components, proven through integrated testing and extensive functional experience, to ensure desired performance. Make the matched system components compatible with all types of traffic signal controllers, such as, electro-mechanical or solid-state. Matched components shall provide future system compatibility of all priority control elements.

Furnish all equipment supplied as part of the optical priority remote traffic control system meeting the electrical and environmental specifications spelled out in the current NEMA standards.

All equipment supplied as part of the priority control system intended for use in or on emergency vehicles shall operate properly over an ambient temperature range of –30 °C (–20 °F) to 60 °C (140 °F) and in air with relative humidity from 5% to 95% and a vehicle battery voltage of from 10 V to 15 V.

(b) Optical Emitter Assembly. Furnish an optical emitter assembly, when required in the plans, that is lightweight, weather-resistant, light-emitting device with an internal regulated power supply. Design the optical emitter assembly to produce precisely timed, crystal-controlled optical energy pulses of high-intensity light from a single source, at a rate of 14.035 Hz or 9.639 Hz, depending on the emitter control switch employed.

(c) Optical Detectors. Provide lightweight, weatherproof, adjustable, single or dual-directional optical detectors. Design the internal circuitry to transform optical energy from the optical emitter assembly into electrical signals for delivery up to 305 m (1,000 ft) via optical detector cable to the phase selection equipment.

The optical detectors shall be of high-impact polycarbonated construction with non-corrosive hardware. Design optical detectors for simple mounting at or near an intersection on mast arm, pedestal, pipe, or span wire. Provide optical detectors capable of operating at an ambient temperature range of –30 °C (–22 °F) to 79 °C (174 °F).

The unit shall be responsive to the optical emitter at a distance of at least 550 m (1,800 ft) and shall be capable of providing the necessary electrical signal to the phase selector through up to 305 m (1,000 ft) of optical detector cable.

(d) Optical Detector Cable. Provide durable optical detector cable having the necessary electrical characteristics to carry power from the phase selector assembly to the optical detector and to carry the optical detector signal from the optical detector to the phase selector.

Furnish cable having three conductors, AWG 20 (7 x 28) stranded and an individually tinned drain wire, to provide signal integrity and transient protection. Provide copper cable conductors shielded with aluminized polyester. The shield wrapping shall have a 20% overlap to ensure shield integrity following conduit and mast arm pulls. Provide cable capable of delivering the necessary quality signal from the optical detector to the phase selector assembly over a non-spliced distance of 305 m (1,000 ft). The cable shall deliver sufficient power to the optical detector over a non-spliced distance of 305 m (1,000 ft).

Use cable with a 600 V minimum insulation rating and a temperature rating of at least 80 °C (176 °F).

Color code cable orange for delivery of optical detector power (+), blue for optical detector power return (–) or optical detector signal, yellow for optical detector signal, and bare for optical detector power return (–).

(e) Phase Selector Assembly. Furnish phase selector assemblies that interface between the optical detectors and the controller unit, maintain the existing controller unit's fail-safe provision, and provide sufficient power for up to three optical detectors per channel.

The assembly shall provide suitable sensitivity to the optical detector signal via adjustable range potentiometers.

Provide a plug-in, two or four channel, dual-priority device intended to be installed directly into the input file of control cabinets equipped with priority phase selection software.

The assembly shall be powered from AC mains and contain an internal, regulated power supply to power optical detectors.

Furnish an assembly capable of recognizing 9.639 ± 0.119 Hz as Frequency I and 14.035 ± 0.255 Hz as Frequency II pulse rates as delivered by the optical detectors.

The assembly shall deliver signals to the controller to cause selection of the desired phase green display for the approaching vehicle.

Equip the assembly with a test switch for each channel to deliver Frequency I or Frequency II signal pulse rates to verify proper function at both optical emitter flash rates, first-come, first-served operation, and Frequency II override capability.

The assembly shall have a selectable call dropout time of 5 or 10 seconds, 0 to +2.5%.

**623.02.30 Inductive Loop Vehicle Detectors.** The term “loop vehicle detector” applies to a complete installation consisting of a loop or group of loops installed in the roadway, as shown on the plans, lead-in cable and a sensor units (amplifier) with integral power supply installed in a traffic signal controller cabinet.

(a) General. Use vehicle detectors of the type as specified in the Plans and Contract Special Provisions.

Install the loop detector conductors before placing the final surface course on new paving projects. Install the conductors as shown on the plans, in the compacted layer of asphalt concrete immediately below the uppermost layer.

Adjust loop detector layouts on Portland cement concrete pavement to avoid the transverse weakened plane joints.

Circular loop detector with a 1.8 m (6 ft) diameter may be installed, in lieu of the 1.8 m x 1.8 m (6 ft x 6 ft) loop detectors shown in the plans.

Also, a series of circular loop detectors with a 1.8 m (6 ft) diameter may be installed, upon approval of their spacing, in lieu of the rectangular 1.8 m x 6 m (6 ft x 20 ft) loop detectors shown in the plans.

(b) Sensor Unit Amplifiers. The detector shall be rack or shelf mounted, as indicated in the plans, in a traffic signal controller cabinet, connected to the cabinet wiring through 44 terminal cinch jones connector (50-44-30m) and wire harnesses.

All detectors shall be one or two-channel type with independent channel controls. When called for in the contract, each channel shall include a delay/extension time function and/or count function.

All loop detectors shall utilize digital design throughout, for threshold, time, and cycle calculations. Use period measurement, the time elapsed per cycle, frequency measurement, or the cycles counted in a set time interval techniques to determine a change in inductance.

The two-channel construction shall ensure isolation of the channels to eliminate “cross talk” between adjacent loops. Period measurement detectors shall use alternate scanning to accomplish this isolation.

The detector shall include a fail-safe to call feature on each channel to provide a detect output in the event of open circuit loops. The minimum composite loop inductive operating range shall be 50 to 1,000 microhenries and shall allow up to 305 m (1,000 ft) of loop lead-in. Detectors may be self-tuning with automatic tracking or require initial tuning with a minimum automatic drift compensation range of ± 5%, after initial adjustment. Detector outputs shall be optically coupled. The output shall be fail safe (closed) in the event of power loss.

Operational selections or adjustments shall be made by digital switches on the front panel. A minimum selection of three frequency ranges and three sensitivity (change in inductance) ranges shall be provided along with a presence or pulse output mode and a reset selector. Controls shall be separate and repeated for each channel.

Provide an output indication (LED) for each channel and locate the indicator on the front panel.

Furnish loop detector amplifier channel conforming to NEMA TS-2 specifications.

(c) Conductor. Loop detectors may consist of 14 AWG stranded copper wire with cross-linked polyethylene (XHHW) insulation conforming to requirements of IMSA Specification No. 51-3, encased in a flexible vinyl plastic or polyethylene tubing with an inside diameter of 5 mm (0.197 in.), a minimum wall thickness of 0.8 mm (0.0315) and a minimum outside diameter of 6 mm (0.236 in.). Provide smooth bore, highly abrasion resistant tubing capable of resisting deterioration from oils and solvents. Insert the wire into the vinyl plastic or polyethylene tubing for the full length from the point of splicing and place into the slot with the number of turns as shown on the plans. At the time of placing the loop wire in the sawed slots, seal the ends of the tubing to prevent any entrance of moisture into the tubing.

(d) Lead In Cable. Use loop lead-in cable to connect the loop installed in the pavement to the loop detector unit installed in the controller cabinet.

Loop lead-in cable shall be No. 16 AWG copper, polyethylene insulated twisted pairs, shielded and enclosed within a polyethylene jacket. Use loop lead-in cables conforming to IMSA Specification No. 50-2.

(e) Loop Detector Sealant. Use loop sealant as a filler for loop saw cuts, and to secure and protect the loop wire. The sealant shall have sufficient strength and hardness to withstand stress and abrasion from vehicular traffic and still remain flexible enough to provide stress relief under thermal movement.

In addition, the sealant shall have the ability to bond to both concrete and asphalt, have a rapid cure rate so that the pavement may be open to traffic within 30 minutes after installation, initial fluidity to permit installation in a narrow saw cut down to at least 4.4 °C (40 °F), moisture insensitivity so that it may be applied to damp pavement effectively, and resistance to vehicular fluids and road salt.

Use a loop sealant approved by the maintaining agency. Manufacturers of loop sealants are listed in the QPL. If electing to use an epoxy loop sealant, use an epoxy loop sealant conforming to Subsection 728.03.05.

(f) Installation Details. Installation and tests shall conform to the details and notes shown on the plans.

Saw cut slots in pavement. Chip off sharp edges and 90 degree corners. Blow saw cuts clean and dry with compressed air to remove all excess moisture and debris before installing inductive loop detectors. For repairing damaged saw cuts, clean away all loose spalled material from saw cut, chip back to sound asphalt concrete or Portland cement concrete and clean all loose material from loop wire.

Unless shown otherwise, each loop shall consist of three turns of conductor as specified in subparagraph (c) of this Subsection.

Twist lengths of loop wires that are not imbedded in the pavement with at least 5 turns per meter (yard) between roadway and pullbox. Splice between loop wire and detector cable in the pullbox in a satisfactory manner.

In addition to the required tests, check each detector loop for continuity before filling slot with epoxy or sealant. Insulation test for each loop to ground shall not be less than 10 megaohms, using an approved insulation testing device. See Subsection 623.03.21.

Fill the slots with sealant to within 3 mm (1/8 in.) of the pavement surface. Place the sealant at least 25 mm (1 in.) thick above the top conductor in the saw cut. Before setting, remove surplus sealant from the adjacent road surfaces without the use of solvents.

Continuously run conductors of all loops to be operated by each sensor unit, without splices, to the nearest pull box. Join the loops in the pull box in combination of series and parallel so that optimum sensitivity is obtained at the sensor unit. Do not make final splices between loops and lead-in cable until the operation of the loops under actual traffic conditions is approved.

Splice all loop conductors for each direction of travel for the same phase of a traffic signal system in the same pull box, to a cable which runs from the pull box adjacent to the loop detector to a sensor unit mounted in the controller cabinet.

Terminate all loop conductors for traffic counters in a pull box or on a terminal strip in the traffic count station cabinet when such a cabinet is installed.

Identify and band conductors for inductive loop traffic signal and traffic counting installations in pairs, by lane, in the pull box adjacent to the loops and near the termination of the conductors in the controller or traffic count station cabinet. In the pull box, also identify each loop at the beginning and ending of each pair. Bands shall conform to Subsection 623.02.21.

Do not provide sensor units for inductive loop traffic counting installations.

Where detector lead-in cables are spliced or are spliced to loop conductors or magnetometer detector leads, solder the splices by the hot iron, pouring, or dipping method. Do not open flame solder. Join conductors by the use of UL listed pressure connectors or other approved method. Insulate splices by one of the following methods:

1. Thermosetting Epoxy Compound. Pour a 2 part liquid thermosetting self-curing epoxy resin, where the 2 parts are mixed just before use, into molds of dimensions suitable for the splice.

2. Thermosetting Polyurethane Compound. Pour a 2 part liquid thermosetting self-curing polyurethane resin, where the 2 parts are mixed just before use, into molds of dimensions suitable for the splice.

(g) Preformed Loop Detectors. At own option, preformed inductive loops may be installed, when approved, as an alternative to saw cut loops.

Preformed loop detectors may be used where they will be overlayed with a new dense-graded plantmix surface course of at least 50 mm (2 in.) in compacted thickness. Do not place preformed loop detectors in saw cuts. Anchor the preformed loop detectors to the existing pavement or base course to prevent movement during the paving operation.

No single component or connector of the detector may have a dimension greater than 25 mm (1 in.) in width when laid flat against the existing roadway surface or base.

The detector wire shall not be less than No. 16 AWG, THHN or TFFN stranded. Encase detector wires in a polypropylene conduit, resistant to asphalt penetration and heat. Expansion joints may be used to allow for expansion and contraction of the roadway surface.

Encase lead-in wires in a flexible, sealed 15,500 kPa (2,248 psi) conduit. Fill all conduits with a rubber asphalt sealant to allow flexibility and to prevent moisture from entering the conduit. All preformed loops shall have four turns of wire.

Do not splice the lead-in wire to the loop detector wire. Run wire continuous from head to tail.

Determine the actual required length of the encased lead-in wires. No additional compensation will be allowed for the actual length of lead-in wires.

Manufacture and install the preformed loop detectors in an approximately 1.8 m (6 ft) square or round shape.

**623.02.31 Pedestrian Push Buttons.** Furnish ADA (Americans With Disabilities Act) compliant pedestrian detector assemblies.

Use machined or die-cast aluminum for the push buttons. Powder coat push buttons with paint matching Color No. 37038 as shown in Table VIII of Federal Standard No. 595B.

Provide a weatherproof assembly and so construct to be shockproof under any weather condition.

Furnish pedestrian push buttons of a precision type, single pile, single throw, expansible to three poles, single throw operation, having pressure type terminals rated at 120 VAC, and capable of $1 \times 10^6$ operations.

Provide UL listed, CSA certified switches which meet the requirements of NEMA ICS-1, ICS-2, and having the following characteristics:

1. Stainless steel or aluminum operator switching units, mounted within the housing with a stainless steel, non corrosive, tamperproof, fastening device of such a size to permit recessed mounting in most existing standard type pedestrian push buttons without any modifications to either unit.

2. Semi-hemispherical in shape actuator with the cone extending 11 mm (7/16 in.) to 13 mm (1/2 in.) above the bezel of the switch housing, and 50 mm (2 in.) in diameter.

3. A switch with an operating force of 2.5 to 3.6 N (9 to 13 ounces) and a minimum release force of 1.1 N (4 ounces). Pretravel shall be 0.4 mm (1/64 in.) maximum. Overtravel shall be 5.6 mm (7/32 in.) minimum. Differential travel shall be 0.01 to 0.05 mm (0.0004 to 0.002 in.).

Install push button and sign on the crosswalk side of the pole.

Point arrows on push button signs in the same direction as the corresponding crosswalk.

Make pedestrian push button signs of porcelain enameled metal.

TRAFFIC SIGNAL ASSEMBLIES

**623.03.01 General.** Furnish material conforming to these Specifications, Equipment and Material Standards of the Institute of Transportation Engineers (ITE), and the Standards of the maintaining agency.

**623.03.02 Vehicle Signal Housing.** Each vehicle signal housing shall be of the adjustable type conforming to the requirements in the ITE Publication: ST-017A. “Equipment and Material Standards.”

Construct traffic signal heads, pedestrian heads, and all component parts of die cast aluminum.

Unless otherwise shown on the plans, all vehicle signal faces shall contain three sections arranged with the red on top, yellow in the center, and green on the bottom.

Use the same make and type signal faces at all locations for any one intersection.

Orient vehicle and pedestrian signal mountings so as to provide maximum horizontal clearance to the adjacent roadway.

The signal face housing, or case, shall consist of an assembly of separate interchangeable sections, expandable type for vertical mounting without tie rods, substantially secured together in a watertight manner to form a unit. Each section shall house an individual optical unit.

Each housing section shall be complete with a one piece, hinged door mounting for the lens and other parts of the optical system, water-tight gaskets, and a simple door-locking device. Mount the optical system so that the various parts may be swung open for ready access or removal. Make the sections interchangeable and construct so that sections can be removed or added. Provide a round opening in the top and bottom of each head to receive 40 mm (1 1/2 in.) supporting pipe frame. Make parts of the housing, including the doors and end plates, of die cast or permanent mold-cast aluminum conforming to ITE Publication ST-017A, and provide all parts clean, smooth and free from flaws, cracks, blow holes, or other imperfections.

Provide exposed bolts, screws, hinge pins, door-locking devices and other hardware of stainless steel. Provide interior screws and fittings of stainless steel or approved nonferrous, corrosion resistant material.

Make gaskets, including door, lens, and reflector gaskets, but not including lamp receptacles gaskets, of neoprene. Make lamp receptacles gaskets of material not affected by heat. The lamp receptacles gasket will not be required when the lamp receptacles is not in direct contact with the glass reflector.

Wire lamp receptacles so that a white wire will be connected to shell of the lamp receptacles and a black or colored wire to the bottom or end terminal of the lamp receptacles. These wires shall, in turn, be connected to the terminal block mounted inside at the back of the housing. Provide the terminal block with sufficient screw type terminals so as to terminate all field wires and lamp wires independently, with separate screws. Permanently identify the terminals to which field wires are attached or use color coded wiring to facilitate field work.

Use lamp receptacles wires of No. 18, or larger, 600 V, appliance wiring material (AWM), with 0.75 mm (0.0313 in.) thickness thermoplastic insulation rated 105 °C (221 °F) or insulation that conforms to MILW-16878 D, Type B, with vinyl nylon jacket rated 115 °C (239 °F) and exceeds ITE requirements Section 13.02 Wiring.

Mark the manufacturer’s name or trademark, wire size, insulation type-letter designation and temperature rating on the insulation or submit a Certificate of Compliance conforming to the provisions in Subsection 106.05, by the manufacturer with each shipment of traffic signal head units.

Provide each lens with a removable hood, conforming to ITE Publication ST-017A, 1.3 mm (0.05 in.) minimum thickness, of sheet aluminum of the tunnel type, open at the bottom and ends. Make hoods for 200 mm (8 in.) section a 180 mm (7 in.) minimum length and for 305 mm (12 in.) section a 240 mm (9.5 in.) minimum length unless otherwise shown on the plans. Make hoods with a minimum downward tilt of 3.5 degrees.

Construct each signal section in such a manner that structural failure of the housing will not occur with a wind load pressure of 1,200 Pa (0.174 psi) on the projected area of the complete signal face housing, including back plate and hoods.

Each optical unit shall consist of an assembly of a lens, reflector, a lamp receptacle, and other components as required.

Make lenses of either glass or ultra-violet stabilized plastic conforming to the appropriate ASTM specification for the plastic being used. Plastic lenses shall not distort due to heat from the highest wattage lamp required. Provide lamps conforming to the ITE Publication ST-017A.

Provide signal faces with 305 mm (12 in.) sections or as shown on the plans.

Provide all green arrow signal indications with a uniform prismatic diffusing or equal interior surface. Configuration, backing, color, and marking of the arrow lens shall conform to the requirements of the ITE Publication ST-017A.

Make reflectors of silvered glass, specular aluminum with an anodic coating, or metalized plastic conforming to ITE Publication ST-017A.

Lamp receptacles shall conform to ITE Publication ST-017A.

Design each optical unit, including lens, reflector, lamp, and visor to minimize the return through the lens of outside light entering the lens at low sun angles, to prevent the effect termed Sun Phantom.

**623.03.03 Lamps.** Provide the type of lamps specified in the plans.

Furnish traffic signal lamps conforming to the ITE Standard for Traffic Signal Lamp. A minimum of 60 watt, 590 lumens, 120 volt, clear, traffic signal lamps of 8,000 hour minimum rated life shall be furnished with 200 mm (8 in.) signal heads and 300 mm (12 in.) pedestrian heads. A 150 watt, 1,750 lumens, 120 volt, clear, traffic signal lamp of 6,000 hour minimum rated life shall be furnished with 300 mm (12 in.) traffic signal heads.

Furnish traffic signal heads with red, yellow, and green light emitting diode (LED) modules meeting the requirements in the ITE Standard titled “Vehicle Traffic Control Signal Heads” (VTCSH). The colors of the LED traffic signal modules shall conform to the chromaticity requirements of Section 8.04 and Figure 1 of the VTCSH standard.

Furnish and install red, and yellow LED modules and red tattletale lights that utilize AlInGaP technology. Green LED modules shall utilize InGaN technology. Use lights meeting the requirements set forth in the Interim LED Purchase Specification of the ITE, VTCSH, Part II: LED Vehicle Traffic Signal Modules, latest edition, except provide yellow LED modules with intensity that is at least twice the intensity of red LED sections.

Provide a minimum five year warranty for red, yellow, and green LED modules and red tattletale lights. With the submittal information, provide certification from a qualified independent test facility, that red, yellow, and green LED modules meet the requirements of the latest edition of ITE, VTCSH, Part II, including the exception stated for yellow LED modules.

Lamps for existing and temporary 200 mm (8 in.) units shall be 69 W maximum, 550 lm minimum initial, clear, 8,000 hour life, 62 mm (2.441 in.) Light Center Length, 120 V traffic signal lamps. Traffic signal heads of a 200 mm (8 in.) size may only be used as temporary equipment or when specified.

Lamps for the 305 mm (12 in.) units shall be 150 W maximum, 1,650 lm minimum initial, clear, 8,000 hour life, 75 mm (3 in.) Light Center Length, 120 V traffic signal lamps.

Position the lamp in the lamp holder to provide lamp filament orientation with the open portion of the filament facing upward or as recommended by the manufacturer of the lamps.

**623.03.04 Directional Louvers.** Where shown on the plans, furnish and install louvers in signal hoods. Construct directional louvers so as to have a snug fit in the signal hoods. Construct the outside cylinder of 0.8 mm (22 gage) sheet steel and construct the vanes of 0.4 mm (27 gage) sheet steel or construct the cylinder and vanes of ASTM B209, 3003-H14 aluminum alloy of similar construction. Thickness dimensions and arrangements of vanes shall be as shown on the plans.

**623.03.05 Back Plates.** Construct back plates of ASTM B209, 3003-H14 aluminum alloy sheet 1.3 mm (0.051 in.) minimum thickness, and of the dimensions shown on the plans.

Where a back plate consists of 2 or more sections, fasten the sections with rivets or with aluminum bolts, peened after assembly to prevent loosening.

Provide mast arm mounted, bracket mounted and post top signal heads and programmed visibility signal heads with back plates.

No background light shall show between the backplate and the signal face or between sections.

**623.03.06 Signal Head Mounting.** Support bracket mounted signal heads, as shown on the plans, by mounting brackets consisting of watertight assemblies of 40 mm (1.5 in.) standard steel pipe and malleable iron, ductile iron, or brass pipe fittings. Set members either plumb or level, symmetrically arrange, and securely assemble. Construct so that all conductors are concealed within the assembly.

The dimensions of mounting brackets between the axis through the center of the terminal compartment, or slip-fitter, shall not exceed 280 mm (11 in.), except where required to provide proper signal head alignment.

At each signal location, unless otherwise shown on the plans, construct a terminal compartment into the mounting brackets. Fit each compartment with a terminal block containing 12 poles, each with two screw type terminals. Each terminal shall accommodate at least five No. 14 conductors. Provide a rain-tight cover, giving ready access to the terminal block. Make the terminal compartment from bronze of sufficient strength to remain intact in the event the pole is knocked down. Make slip-fitters, where used without integral terminal compartment, of cast-iron or bronze.

For post-top mounting of bracket mounted signals, cast the terminal compartment with an integral slip-fitter. For post-top mounting of a one way signal head, a slip-fitter without a terminal compartment may be used. Slip-fitter shall fit over a 100 mm (4 in.) standard pipe or 115 mm (4.5 in.) outside diameter end of tapered standard pipe. Provide each slip-fitter with 2 rows of steel set screws, with 3 screws in each row to secure the assembly in plumb position. Use cadmium plated set screws.

Where signal heads are side mounted on poles, design the terminal compartment to bolt securely to the pole.

Equip signal heads with positive brass lock rings and fittings designed to prevent heads from turning due to external forces. Provide lock ring and connecting fittings with serrated contacts as shown on the plans.

Equip signal head assembly for suspension from mast arm with a slip-fitter as shown on the plans.

Do not install signal heads at any intersection until all other signal equipment, including the controller, is in place and ready for operation at that intersection, except that the signal heads may be mounted if the faces are not directed toward traffic or if the faces are covered.

**623.03.07 Pedestrian Signals.** All pedestrian signal heads must meet the requirements of ITE Publication ST- 017A, VTCSH: Part 2: Light Emitting Diode (LED) Vehicle Traffic Control Signal Modules.

(a) Faces. Provide pedestrian signal faces as required by the maintaining jurisdiction, otherwise the message symbols for pedestrian signal faces shall be lunar white “WALKING PERSON” and Portland orange “UPRAISED HAND” conforming to ITE Standards: “Pedestrian Traffic Control Signal Indications” and the “Manual of Uniform Traffic Control Devices,” unless otherwise specified in the Special Provisions. Make the height of each symbol not less than 250 mm (10 in.) and the width of each symbol not less than 165 mm (6.5 in.).

Use the same make and type of pedestrian signal faces at any one intersection.

Provide each signal with a 38 mm (1.5 in.) deep egg-crate or Z-crate visor designed to eliminate sun phantom.

(b) Housing. Provide either die-cast or permanent mold-cast aluminum signal section housings conforming to ITE Publication ST-017A.

Make the housing for pedestrian signals dustproof, weatherproof, and corrosion resistant and provide for easy access to, and replacement of, all components.

Make the housing suitable for either post-top or bracket mounting.

(c) Finish. Paint the outside of the housing according to Section 614.

**623.03.08 Programmed Visibility Traffic Signal Heads.** Programmed visibility traffic signal heads and the installation thereof shall conform to Subsections 623.03.02, 623.03.05, and 623.03.06, except the provisions in Subsection 623.03.02 for the removable hood shall not apply.

Make the visibility of the signal indication adjustable within the signal head to fit the lane or lanes in which traffic is to be controlled.

External illumination shall not cause a signal indication nor shall a signal indication in one signal head cause a signal indication in another signal head.

Each section of a signal face shall provide a 305 mm (12 in.) diameter, round or arrow indication. Color and arrow configuration shall conform to ITE Publication ST-008B.

Provide each section with a sun visor.

The indication of each signal head, when unprogrammed, shall be visible from anywhere within 15 degrees of the optical axis. Provide signal head capable of being preset at angles between 9 degrees above and 9 degrees below the horizontal and be preset at 5 degrees below the horizontal, unless otherwise specified.

The signal head with yellow indication, before programming, shall provide a minimum candlepower of 2,500 cd in the direction of the axis and a maximum candlepower of 100 cd at 15 degrees horizontally in each direction from the axis. Provide said signal head with yellow indication capable of being programmed so that a minimum candlepower of 2,500 cd can be directed along the optical axis and a candlepower of less than 100 cd directed at 0.5 degrees horizontal from the axis and no measurable light is directed from one degree to 15 degrees horizontal from the axis. Under the same conditions, the candlepower of the red indication shall be at least 19% of the yellow indication and the candlepower of the green indication shall be at least 38% of the yellow indication.

Lamps for the signal units shall be 150 W, 120 V, incandescent lamps with a minimum average rated life of 6,000 hours.

During daylight, the signal indications shall be visible only in those areas or lanes designated. During dusk and darkness, a faint glow visible to the side will be permissible.

Provide dimming devices to gradually reduce the candlepower of each signal head for nighttime operation to approximately 15% of that for daytime operation.

Program the head as provided by the manufacturer.

**623.03.09 Traffic Signal Signs.** Traffic signal signs shall conform to the requirements of permanent signs in Section 627.

**623.03.10 Protective/Permissive Left Turn Signal Heads.** Furnish and install the protective/permissive left turn signal heads (cluster type) for mast arms and accompanied five section bracket mounted heads.

Furnish and install the R10-5d(s), sign unless otherwise indicated on the plans.

**623.03.11 Flashing Beacons.** Install flashing beacons where shown on the plans. Unless otherwise specified on the plans, each beacon shall consist of a single section traffic signal head, conforming to ITE Publication ST-017A, with yellow or red lens as shown on the plans. Mounting of beacons, including span-wire mounting if required, shall be as shown on the plans.

Each flashing beacon control unit shall consist of a switch, 10 A plug fuse, flasher, and terminal block housed in a single enclosure.

Use NEMA Type 3R enclosure and provide with top hinged cover, dead front panel, and a hasp for sealing cover. Furnish padlocks for all enclosures.

Provide the enclosure with factory applied, rust-resistant prime coat and baked enamel finish coat. Apply 2 coats of aluminum paint as specified in Subsection 623.02.07. The enclosure may be hot-dip galvanized in lieu of painting.

Provide switches of 10 A, toggle type, single-pole, 2 wire, 120 V, AC, and mount at the top and center of the dead front panel.

When shown on the plans or specified in the Special Provisions, install a 15 A circuit breaker, conforming to Subsection 623.02.08, in lieu of the control switch and 10 A plug fuse specified above.

The flasher shall be solid-state device of adequate capacity and shall have no contact points or moving parts.

Use flashers providing 50 to 60 flashes per minute with a 40% to 60% duty cycle.

Use flashers providing for 2 circuit, alternate operation of beacons and furnish with plug-in mounting.

Use terminal blocks rated at 15 A, 600 V, molded from phenolic material and of the barrier type with plated brass screw type terminals and integral type marking strips.

Provide workmanship and materials equal to that of first class electrical instruments.

When flashing beacons are installed adjacent to or in conjunction with a traffic signal system, install the flasher control in the controller cabinet unless otherwise shown on the plans.

Mount the sign panel on cantilever flashing beacons using galvanized commercial quality 8 mm (5/16 in.) diameter hexagonal head bolts and nuts, galvanized flat washers, and lock washers with a fiber washer contacting the face of the sign panel.

LIGHTING ASSEMBLIES

**623.03.12 Luminaires, General.** Provide high-intensity-discharge luminaires of the enclosed type with horizontal burning lamp and slip-fitted for horizontal mounting on 50 mm (2 in.) pipe. Provide luminaires of either a semi-cutoff or a cutoff type, as indicated on the plans, and provide with a high pressure lamp. Provide semi-cutoff luminaire with a refractor and cutoff luminaires with a flat lens.

Before energizing a luminaire, set the lamp socket in the proper location for the required light distribution according to the manufacturer's instructions, and level the luminaire.

Each luminaire shall consist of a housing, reflector, terminal strip, refractor or a lens, a lamp socket and lamp, and an integral ballast. Glare shields are not required unless indicated on the plans. Fabricate all parts of the luminaire from corrosion-resistant materials.

Fabricate each housing from aluminum by either diecasting or forming. Housings that are painted shall withstand a 1,000 hour salt spray test as specified in ASTM B117. Fabricate glare shields when required from the same materials as the luminaire.

The reflector may be a separate unit or may be integral with the housing. Provide specular reflector surface and protect by an electrochemically applied anodized finish. The reflector configuration shall reflect a minimum of light through the arch tube of the lamp.

Mount each refractor or flat lens in a frame that is hinged to the housing and secure with a spring loaded automatic latch. Gasket the joint between the frame or reflector and the housing. Make each refractor of heat-resisting glass or polycarbonate material as indicated on the plans. Make each flat lens of heat and impact resistant glass.

Each lamp socket shall be a porcelain enclosed mogul-multiple type. The shell shall contain integral lamp grips to insure electrical contact under conditions of normal vibration. Mount socket in the luminaire in a manner to permit presetting a variety of specific light distribution patterns. Weld the socket leads to the screw shell and spring-loaded center contact. Provide socket rated for 1,000 W and capable of withstanding a 6 kV high potential test.

The optical system (reflector, refractor or flat lens lamp socket and lamp) shall be a sealed chamber with provision for filtered breathing. Breathing shall permit intake and exit of air into or from the chamber as a result of expansion or contraction of air in the chamber due to lamp heat. Accomplish filtering by either a separate filter or a filtering gasket.

Terminate field wires connected to the luminaire on a barrier type terminal block secured to the housing. Provide captive terminal screws equipped with wire grips for wire up to No. 6. Pre-wire all components to a single strip assuring that field connections are made to clearly identified line terminals.

Each integral ballast shall be as specified in Subsection 623.03.19. Where the components are mounted on a down-opening door, hinge and secure the door separately from the refractor or flat lens frame. The door shall be easily removable and replaceable. Secure the door to the housing in a manner to prevent accidental opening.

Provide in-line fuse holders for all luminaires either in base of pole or in signal controller cabinets.

**623.03.13 High Pressure Sodium Luminaires.** High pressure sodium luminaires shall meet the requirements of Subsection 623.03.12.

Furnish each high pressure sodium luminaire with a 100 W, 250 W, 400 W, 1000 W or other wattage high pressure sodium lamp as indicated on the plans.

The light distribution for luminaires shall correspond to the IES type shown on the plans.

Operate the lamp at the wattage necessary to produce 9,500 lm with the 100 W lamp, 27,500 lm with the 250 W lamp, 50,000 lm with the 400 W lamp and 140,000 lm with the 1000 W lamp.

**623.03.14 Soffit and Wall Luminaires and Lamps.** Provide soffit and wall luminaires of the type or types specified.

Before energizing a luminaire, set the lamp socket in the proper location for the required light distribution according to the manufacturer's instructions, and level the luminaire.

Provide weatherproof and corrosion resistant soffit and wall luminaires. Installation details and minimum light distribution shall be as shown on the plans.

Each flush-mounted soffit luminaire shall consist of a cast metal body, a prismatic refractor mounted in a door frame, a prismatic glass reflector and a socket. Provide the body with a continuous anchor ring and with four 50 mm (2 in.) conduit hubs. Hinge, gasket, and secure the door frame assembly to the body by at least 3 machine screws. Clearly identify the refractor as to "street side" and key so as to fit into the frame in only one way.

Unless otherwise specified, furnish each flush mounted soffit luminaire with an integral ballast mounted on a bracket so constructed that the light center of the lamp is within 13 mm (1/2 in.) of the light center location for which the luminaire is designed.

Enclose and gasket each pendant soffit luminaire, and furnish with aluminum finish, 20 mm (3/4 in.) toptapped head, stepped or fluted reflector, and refractor attached to reflector. Provide the reflector with a specular anodized aluminum finish. Make the refractor of heat-resistant acrylic plastic or glass. Hinge and latch the optical assembly for lamp access and provide with a safety chain.

Furnish each pendant soffit luminaire with a 3.2 mm (11 gage) minimum thickness, metal box, maximum dimensions of 200 mm by 230 mm by 280 mm (8 in. by 9 in. by 11 in.) for housing the ballast for the luminaire. Provide the box with a gasketed cover with 2 captive screws and hinges to prevent dropping. Hotdip galvanize the box.

Each wall-mounted luminaire shall consist of a cast metal body of the dimensions shown on the plans. The lens frame shall be gasketed and allow servicing without detachment from the body.

Give cast metal bodies made of aluminum, which are to be flush mounted in concrete, a heavy coat of alkali-resistant bituminous paint on all surfaces to be in contact with concrete. Paint shall conform to MILP-6883.

Unless otherwise specified, furnish each soffit luminaire and each wall luminaire with a hard glass type, 150 W, high pressure sodium vapor lamp, with a minimum average rated life of 24,000 hours.

**623.03.15 Sign Lighting Fixtures.** Use sign lighting fixtures listed in the QPL.

**623.03.16 Sign Switches.** Provide each sign illumination installation with a disconnect switch mounted on the sign standard or structure, as shown on the plans.

Use NEMA Type 3R enclosure for the sign switch. Galvanize or provide with a factory applied rust resistant prime coat and baked enamel finish coat, in lieu of galvanizing. Provide with top hinged cover, hasp for sealing cover, and provisions for locking the handle in the "On" and "Off" positions. Furnish padlocks for all sign switch enclosures.

When specified in the plans, provide a circuit breaker in lieu of the above fused switch. Use circuit breakers meeting the requirements of Subsection 623.02.08, and conforming to the requirements of the NEC to protect conductors and equipment.

Fuse switch or circuit breaker to protect each 'hot leg' (potential to neutral or derived neutral). Provide multiple pole circuit breakers with a common trip.

If the sign structure is to be painted, paint the sign switch or circuit breaker enclosure the same color as the sign structure on which it is installed.

**623.03.17 Internally Illuminated Street Name Signs.** The unit shall consist of a premanufactured internally illuminated street name sign mounted on a signal pole, street light pole, or mast arm.

(a) General. Furnish internally illuminated street name signs conforming to the details shown on the plans and as specified. Install signs by Method 1 or Method 2, as shown on Standard Plan Sheet T 30.1.3.2, as specified in the plans. Minor details of construction shown are typical and may be modified subject to approval.

Design and construct the sign fixture to prevent deformation or failure when subjected to 113 km/hr (70 mph) wind loads in conformance with the requirements in the AASHTO publication, "Standard Specifications for Structural Supports of Highway Signs, Luminaires and Traffic Signals," and amendments thereto. Submit a Certificate of Compliance from the manufacturer with each lot of internally illuminated street name signs stating that the internally illuminated street name signs meets the wind load requirements as described above.

Galvanize or cadmium plate all ferrous parts, unless otherwise specified herein or shown otherwise on the plans.

Use Type 3AG, miniature, slow blowing type fuses with appropriate current and voltage ratings. Use a panel-mounting type fuse holder with threaded or bayonet type knob which grips the fuse tightly for extraction. Provide a separate fuse for each ballast.

The total mass of the complete sign assembly, including lamps, ballasts, mounting brackets and appurtenances shall not exceed 30 kg (65 lb).

(b) Housing. The top and bottom shall be formed or extruded aluminum and attached to formed or cast aluminum end fittings. Design housing to provide continuous sealing between top and bottom assemblies and the end fittings. Rigidly construct the housing to resist torsional twist and warp. Make provisions for ease of maintenance of all components.

The opening or removal of one panel shall permit access to the interior of the sign and allow for replacement of lamps, ballasts and fuses.

Do not use photoelectric unit sockets.

At own option, furnish Type A or Type B signs. For Type A signs, hinge both sides at the top to permit installation or removal of the sign panels, and access to the interior of the sign. For Type B signs, the sign panels shall be slide-mounted into the housing.

Reflectors may be used to provide the required sign brightness. Construct reflectors from formed aluminum with acrylic baked white enamel surface having a minimum reflectance of 0.85.

Terminate all wiring connections in the fixture on molded, phenolic, barrier type, terminal blocks rated at 15 A, 1000 V, and having integral type, white, waterproof marking strips. Insulate all current carrying parts of the terminal block from the fixture with integral plugs or strips to provide an insulating value in excess of the line-to-ground flashover voltage. If electing to use sectionalized terminal blocks, provide each section with an integral barrier on each side capable of rigid mounting and alignment. Terminal screws shall be size No. 10, minimum.

Provide screened weep holes at strategic locations in all members subject to the collection of moisture. Shield weep holes to prevent light leakage from the fixture.

All fasteners, screws, and hardware shall be of passive stainless steel, Type 302 or 304, or aluminum Type 6060-T6.

The top of the fixture housing shall have 2 free-swinging mounting brackets. Make each of the brackets adjustable vertically for leveling the sign to either a straight or curved mast arm. The bracket assembly shall permit the fixture to swing perpendicular to the sign panel.

Hinge pins for the free-swinging brackets shall have a minimum diameter of 6 mm (1/4 in.). Provide at least 4.6 m (15 ft) clearance between the bottom of the fixture and the roadway.

(c) Sign Panels. Provide slide-mounted or rigid mounted sign panels in a frame, with white legend, symbols, arrows, and border on each face, as shown on the plans. The background shall be green.

Provide uniform illumination on the entire surface of the sign panel. The average of brightness readings for the letters shall be 500 cd/m$^2$ (46.5 cd/ft$^2$ ), minimum. The light transmission factor of the sign panel shall provide a letter to background brightness ratio of between 10 to 1 and 20 to 1. The luminance of the background shall not vary by more than 40% from the average of background brightness reading. The luminance of the letters, symbols and arrows shall not vary by more than 20% from the average brightness reading of letters, symbols and arrows.

Use 4.8 mm (3/16 in.) minimum thickness high impact resistant plastic glass fiber reinforced acrylated resin, polycarbonate resin, or cellulose acetate butyrate plastic panel in a watertight frame.

The sign panels shall not crack or shatter when a 25 mm (1 in.) diameter, steel ball with a mass of 67 grams (0.15 lb) is dropped from a height of 2.6 m (8.5 ft) above the sign panel to any point of the sign panel. The panels shall be lying in a horizontal position and supported within their frame for this test.

Provide the type of sign sheeting shown on the plans. Apply the sheeting to the panels as specified by the sheeting manufacturer.

Display the message, as shown on the plans, on both sign panels. If not shown on the plans, the message, and the size of symbols or arrows will be furnished. Unless shown otherwise, provide 200 mm (8 in.) upper case and 150 mm (6 in.) lower case, Series E, letters.

(d) Lighting. Use the type of lamps shown on the plans and conforming to requirements in ANSI Standard C 78.

Use lamp receptacles listed by UL or ETL for outdoor use, and provide with silver coated contacts and waterproofed entrance leads for use with a rapid-start fluorescent lamp. Removal of the lamp from the socket shall de-energize the primary of the ballast. Provide each lamp receptacle with a heat-resistant, circular cross section, partially recessed neoprene ring to seal against the lamp ends and protect electrical contacts from moisture and dirt or other injurious elements.

Provide one spring-loaded type lamp receptacle for each lamp. The distance between the face of the lamp receptacle for each lamp shall provide a compression of at least 2.5 mm (0.1 in.) on the spring-loaded type lamp receptacle when the lamp is in place. The lamp shall have positive mechanical and electrical contact when the lamp is in place. The socket on the spring-loaded lamp receptacles shall have sufficient travel to permit installation of the lamp. Springs for lamp receptacles shall not be part of the current carrying circuit. Lamp receptacles shall match lamp requirements and shall not increase cathode filament circuit resistance by more than 0.10 ohms.

Ballasts shall be of the high power factor type and shall be capable of starting the lamps at –20EC and above.

Furnish ballasts for Type A signs rated at 200 mA. Furnish ballasts for Type B signs rated at 430 mA. Use ballasts listed by UL or ETL for operation on 110 to 125 V, 60 Hz circuits, and conforming to the requirements in ANSI Standard C 82.1 and ANSI Standard C 82.2.

Provide a separate ballast for each lamp.

All fixture conductors shall be UL or ETL listed appliance wiring material (AWM) stranded copper wire with 0.7 mm (0.03 in.), minimum, thermoplastic insulation, rated at 1,000 V and rated for use at 90EC. Conductors shall be No. 16, minimum, and shall match the color coding of the ballast leads.

Secure all conductors within the fixture with easily removable spring cross straps (not clamped) in the chassis or fixture. Install straps not more than 300 mm (12 in.) apart.

Terminate stranded copper conductors connected to screw type terminals in approved crimp type ring connectors.

Do not make splices within the fixture unless approved in writing.

**623.03.18 Solar Photovoltaic Array.** The solar photovoltaic array requirements shall be specified in the plans and Special Provisions.

**623.03.19 Multiple Circuit Ballasts.** Design each ballast for a high-intensity-discharge lamp for the type, characteristics, and wattage of the lamp it is to operate and provide the proper starting and operating wave forms, voltage, and current. Ballasts shall provide reliable lamp starting and operation at ambient temperature down to –30 °C (–22 °F) for the rated life of the lamp.

Design ballasts for continuous operation at ambient temperatures from –30 °C to 65 °C (–22 °F to 149 °F), and with an average design life not less than 100,000 hours. Design ballasts to operate continuously for 6 months without reduction in life, over the specified temperature range, with the lamp operating normally or with the lamp circuit in an open or short circuited condition.

Test integral ballasts within the luminaire and rate at the temperature normally found within the luminaire.

Starting aids for ballasts of a given lamp wattage shall be interchangeable between ballasts of the same wattage and manufacturer without adjustment.

Submit a manufacturer's certificate of compliance conforming to Subsection 106.05, with each lot of integral ballast luminaires and with each lot of ballasts designed for use outside of luminaires. The certificate shall state that the lot of ballasts meets, in every respect, the above requirements and the lamp-ballast specifications of the lamp manufacturer.

The input voltage for ballasts shall be as shown on the plans or as specified in the Special Provisions.

Each integral ballast shall consist of separate components, each of which shall be capable of being easily replaced. A starting aid which is encapsulated will be considered as a single component. Provide each component with screw terminals, NEMA tab connectors, or a single multi-circuit connector. Identify all conductor terminals as to the component terminal to which they connect.

Mount heat-generating components so as to use the portion of the luminaire upon which they are mounted as a heat sink. Locate capacitors as far as practicable from heat-generating components or thermally shield to limit the case temperature to 75 °C (167 °F).

Resin impregnate transformers and inductors for protection against moisture. Use hermetically sealed metal case capacitors, except those in starting aids.

Provide ballasts for luminaires mounted on mast arms, brackets, or lowering assemblies of the magnetic regulator or auto-regulator (CWA) type with the primary and secondary windings electrically isolated and locate within the luminaire housing. The ballast for each horizontally mounted luminaire shall consist of individual components mounted in the luminaire housing or an assembly of components mounted on a metal plate secured in the housing.

Provide ballasts for wall-mounted luminaires of the high power factor reactor type and locate within the luminaire housing.

Provide ballasts for soffit luminaires of the high power factor reactor type and locate within the luminaire housing or, when shown on the plans, in a pull box adjacent to the luminaire.

Provide ballasts for HPS sign lighting fixtures of the high power factor type and locate within the sign lighting fixture, unless otherwise shown on the plans or specified in these specifications.

(a) Regulator Type Ballasts. Each regulator type ballast shall, when operated with the appropriate lamp, have the following characteristics and shall maintain the following lamp operation:

1. The power factor shall not be less than 90% throughout the life of the lamp at nominal line voltage.

2. Lamp wattage at any lamp voltage from nominal through life shall not vary by more than 18% for ± 10% input voltage variation.

3. For nominal input voltage and lamp voltage, the ballast design center shall not vary more than 7.5% from rated lamp watts.

4. Design the ballast so that a capacitance variance of ± 6 % will not cause more than a ± 8% variation in lamp wattage regulation throughout rated lamp life for nominal input voltage.

5. The lamp current crest factor shall not exceed 1.8 for input voltage variation of ± 10% at any lamp voltage from initial through life.

(b) High Power Factor Reactor Type Ballasts. Each high power factor reactor type ballast shall, when operated with the appropriate lamp, have the following characteristics and shall maintain the following lamp operation:

1. The power factor shall be greater than 90% throughout the life of the lamp at nominal line voltage.

2. Lamp wattage at any lamp voltage from nominal through life shall not vary by more than 25% for ± 5% input voltage variation.

3. For nominal input voltage and lamp voltage, the ballast design center shall not vary more than 7.5% from rated lamp watts.

4. The lamp current crest factor shall not exceed 1.8 for an input voltage variation of ± 5% at any lamp voltage, from initial through its life.

**623.03.20 Falsework Lighting.** When required by the Special Provisions, install falsework lighting where vehicular traffic with or without pedestrian traffic crosses through or under structure falsework.

Provide illumination during the hours from dusk to dawn.

Submit a plan of the proposed lighting installations and do not commence falsework construction until such plans have been reviewed. A subsequent review will be made after falsework lights have been placed in operation.

Provide fixtures for illumination of roadway pavement between entrances and exit portals with a RLM standard dome reflector. The reflector shall have a white porcelain enamel finish on the inside and shall be provided with a steel wire guard.

Equip fixtures with high-temperature glazed porcelain medium base sockets and 1.8 m (6 ft) long conductors for splicing, approved by UL for outdoor use.

Provide fixtures fully adjustable with bracket and locking screws on a mounting-plate and providing mounting directly to a standard metal junction box.

Fixtures for pedestrian passageways shall be porcelain box receptacles mounted on standard metal junction boxes and equipped with wire lamp guards. Use porcelain box receptacles rated at 660 W, 250 V. Make wire lamp guards of No. 10 wire and suitable for general construction work.

Use lamps of an approved type.

Illuminate portal faces of falsework on the side facing traffic with 150 W minimum PAR reflector flood lamps mounted on the structure directly over each vertical support adjacent to the traveled way and over the center of each lane. Support each approximately 5 m (16 ft) above the pavement and approximately 1.8 m (6 ft) in front of the portal face. The exact position of lamps will be as directed.

In addition to the overhead lighting, illuminate each side of each vehicular passageway between portals by a string of yellow, 25 W lamps spaced at 3.6 m (12 ft) intervals and mounted between 2.4 m (8 ft) and 2.6 m (8.5 ft) above the pavement.

Aim each flood light in such a manner as to preclude glare to oncoming motorists.

Illuminate the overhead clearance sign mounted on the falsework.

For illumination of roadway pavement between entrance and exit portals, install a continuous row of 150 W fixtures over center of each lane beneath the falsework structure at intervals of not more than 4.5 m (15 ft), with end fixtures not further than 2.1 m (7 ft) inside the portal faces. Mount the fixtures over the pavement at an approved height.

Illuminate pedestrian openings, through or under falsework, with 150 W fixtures centered over the passageway at intervals of not more than 4.5 m (15 ft), with the end fixtures not more than 2.1 m (7 ft) inside the portal faces. Mount the fixtures between 2.9 m (9.5 ft) and 3.2 m (10.5 ft) above the walkway surface.

For roadway pavement and portal face illumination, use No. 10 conductors with Type S insulation. For pedestrian passageways, use No. 10 conductors enclosed in a 40 mm (1.5 in.) unpainted zinc-coated metallic conduit.

Provide not less than 2 branch circuits. Place pedestrian passageway lights and roadway pavement lights on a minimum of one circuit and portal flood lights on a minimum of one separate circuit. Fuse each branch circuit, not to exceed 20 A.

Install the above specified portal lighting on the day that horizontal members are erected and before traffic is permitted to pass under the falsework during the hours from dusk to dawn. Install the other falsework lights as soon as the members on which they are to be supported are in place.

Pay energy costs for falsework lighting.

On each side of each portal entrance, and no farther apart than the least horizontal clearance within the portal, place clearance guides consisting of a panel of boards or a plywood sheet, 1.2 m (4 ft) wide by 2.4 m (8 ft) long, fastened vertically facing traffic with the bottom of the panel 1 m (3 ft) above the roadway. Fasten said clearance guides in place before darkness on the day that vertical supports are erected and kept clean.

Upon completion of the project or when directed, remove falsework lighting equipment from the work site.

**623.03.21 Field Tests.** Test electrical equipment, material, and work before final inspection.

Tests may be made progressively as parts of the work are completed or when all work is complete. Perform tests in the presence of the Engineer. Repair or replace items which fail to test satisfactorily. Include, in the tests, checks of control operation, system voltages, cable insulation and ground resistance and continuity.

Use testing equipment having the following minimum ranges and accuracies:

| Test | Type of Meter | Accuracy |
|---|---|---|
| Voltage | Multimeter | ± 2% of reading |
| Insulation Resistance | Megohmmeter | ± 1% of reading |
| Current | Ammeter | ± 1% of reading |
| Ground Continuity | Low Ohm Meter | ± ¼% of reading<br>± 1 least significant digit |

Use meters calibrated within the last year.

Make a functional test in which it is demonstrated that each and every part of the totally completed system functions as specified. The functional test for each new or modified traffic signal, flashing beacon, highway lighting system, high mast light system, and ramp metering system shall consist of not less than 30 days of continuous satisfactory operation. If unsatisfactory performance of the system develops, correct the condition and repeat the test until the 30 days of continuous satisfactory operation is obtained.

The 30-day operational test period will start when the traffic signal is completely installed and fully operational, including detectors (inductive, video, pedestrian, etc.) and, if applicable, communication with a central management system. Request approval to start the 30-day operational test period in writing.

Measure and record voltage in the cabinet from phase to phase and phase to neutral at no load and at full load. Measure and record voltage readings at the last termination of each circuit.

With all loads connected, measure and record insulation resistance to ground of each circuit at the cabinet. On tests of new cable runs, the readings shall exceed 50 megohms for phase and neutral conductors with a connected load over 20 amperes and shall exceed 100 megohms for conductors with a connected load of 20 amperes or less.

On tests of cable runs which include cables which were existing in service prior to this contract, the resistance readings shall be the same or better than the readings recorded at the maintenance transfer at the beginning of the contract. Take measurements with a megohm meter approved by the Engineer.

Measure and record the current of each circuit, phase main, and neutral. The Engineer may direct reasonable circuit rearrangement. The current readings shall be within 10% of the connected load based on equipment ratings.

Measure and record resistance of the system ground as taken from the farthest extension of each circuit run from the controller (i.e. check of equipment ground continuity for each circuit). Regardless of the length of the circuits, readings shall not exceed 2.0 ohms.

Measure and record resistance to ground of the service grounding electrode. Take measurements with a ground tester as approved by the Engineer. Resistance to ground shall not exceed 10 ohms. If a reading exceeds 10 ohms, add additional ground rods according to NEC Article 250 at no cost to the Department.

If required in the plans, provide a signal timing program acceptable to the maintaining agency.

Make turn-on of new or modified traffic signal systems only after all traffic signal circuits have been thoroughly tested as specified above and a signal timing program has been accepted.

When specified in the contract documents for projects with new traffic signal controllers, provide a qualified manufacturer's representative to be present at turn-on to oversee the initial signal system operation.

Before and after permanently securing detector loops in the pavement, use electronic instruments to test the resistance, inductance, resistance to ground, and quality factor for each loop and lead-in circuit. The loop and lead-in circuit shall have an inductance between 50 and 700 microhenries. The resistance to ground shall be a minimum of 50 megohms under any conditions of weather or moisture. The quality factor (Q) shall be greater than 5.

Test fiber optic cable as specified in Subsection 623.02.20.

Test fiber optic communication systems as specified in the Special Provisions.

Record the results of all testing along with the date of the test; the name of the person performing the test; brand name, model number, serial number of the equipment used during the test; and any other pertinent information and data. Submit the complete document to the Engineer.

**623.03.22 Luminaire Retrieval System.** Use luminaire retrieval systems listed in the QPL.

Install the luminaire retrieval system as shown on the plans and according to the manufacturer's recommendations.

METHOD OF MEASUREMENT

**623.04.01 Measurement.** Conduits, conductors, lead-in cable for loop detectors, signal cable, interconnect cable, coaxial cable, fiber optic cable, and luminaire retrieval systems will be measured by the linear meter (linear foot).

Traffic signal signs will be measured by the square meter (square foot).

Pull boxes, steel poles, luminaries, illuminated street name signs, signal heads, pedestrian signal heads, pedestrian push buttons with signs, loop detectors, emergency vehicle optical detector system, special detector installation, controllers, electrical service, underpass luminaries, sign lighting fixtures, modify controllers, detector amplifier channels, remove and reset light pole, remove and reset signal pole, remove and reset street name sign, remove and reset signal head, remove and reset luminaire, removal of existing signal head, junction boxes, high mast steel poles, high mast head frame assemblies, video image detection systems, and video image detection cameras will be measured by the each.

Removal of existing traffic signal systems, removal of existing lighting systems and modify existing traffic signal system will be measured by the lump sum.

Fiber optic termination units, fiber optic splice units, and integrated fiber optic splice/termination units will be measured by the each, for each complete and functional system.

BASIS OF PAYMENT

**623.05.01 Payment.** The accepted quantities, measured as provided above, will be paid for at the contract price per unit of measurement for the pay items listed below that are shown in the proposal. Payment will be full compensation for the work prescribed in this Section.

Payment will be made under:

| Pay Item | Pay Unit |
|---|---|
| (size) Conduit | Linear Meter (Linear Foot) |
| (size) Pull Box | Each |
| (size) Pull Box, Modified | Each |
| Steel Pole (type) | Each |
| Fiber Optic Cable | Linear Meter (Linear Foot) |
| Integrated Fiber Optic Splice/termination Unit | Each |
| Fiber Optic Splice Unit (number of splices) | Each |
| Fiber Optic Termination Unit (number of terminations) | Each |
| Fiber Optic Splices | Each |
| High Mast Head Frame Assembly | Each |
| High Mast Steel Pole (height) | Each |
| (type) Luminaire (watt) | Each |
| Underpass Luminaire, (size) (type) | Each |
| Illuminated Street Name Sign (type face) (size) | Each |
| Sign Lighting Fixtures (type) | Each |
| Signal Head (size) (type) | Each |
| Pedestrian Signal Head (type) | Each |
| Pedestrian Push Button With Sign | Each |
| Loop Detector (size) | Each |
| Emergency Vehicle Optical Detector System | Each |
| Special Detector Installation | Each |
| (type) Controller | Each |
| (type) Electrical Service | Each |
| Traffic Signal Signs | Square Meter (Square Foot) |
| (size) Conductor | Linear Meter (Linear Foot) |
| (size) Conductor (size) Cable | Linear Meter (Linear Foot) |
| Lead-in Cable for (type) Detector(s) | Linear Meter (Linear Foot) |
| Junction Box | Each |
| Removal of Existing Traffic Signal System | Lump Sum |
| Removal of Existing Lighting System | Lump Sum |
| Modify Existing Traffic Signal System | Lump Sum |
| Modify Controller | Each |
| Loop Detector Amplifier Channels (Existing Cabinet) | Each |
| Loop Detector Amplifier Channels (New Cabinet) | Each |
| Removal of Existing Traffic Signal Head | Each |
| Removal of Existing Signal Head | Each |
| Remove and Reset Signal Pole | Each |
| Remove and Reset Light Pole | Each |
| Remove and Reset Street Name Sign | Each |
| Remove and Reset Luminaire | Each |
| Video Image Detection System | Each |
| Video Image Detection Camera | Each |
| Coaxial Cable | Linear Meter (Linear Foot) |
| Luminaire Retrieval System | Linear Meter (Linear Foot) |

# SECTION 624

## ACCOMMODATIONS FOR PUBLIC TRAFFIC

DESCRIPTION

**624.01.01 General.** This work consists of providing for traffic by constructing detours, using existing streets and roads as detours permitting traffic to pass through construction, and using flaggers, traffic control supervisor, and pilot cars, or a combination of these methods.

MATERIALS

**624.02.01 General.** The materials shall conform to the MUTCD, if applicable, and the requirements herein.

CONSTRUCTION

**624.03.01 General.** While undergoing improvements, keep the road open to all traffic unless otherwise provided for in the contract documents. If the usable roadway is not sufficient to safely accommodate two-way traffic, adequately maintain one-way traffic. Wherever one-way traffic is in effect, do not exceed 1,800 m (6,000 ft) distance or as otherwise approved in writing. Provide and maintain in a safe condition, temporary approaches or crossings and intersections with trails, roads, streets, businesses, parking lots, residences, garages and farms. Snow removal, however, will not be required. Bear all expense of maintaining the roadway over the section of road undergoing improvement and of constructing and maintaining such approaches, crossings, intersections, and other features as may be necessary, without direct compensation, except as provided in Subsection 107.15.

Maintain the roadway during suspension of the work when such suspensions are due to the Contractor's negligence. See Subsection 108.06. During any other suspension, make passable and open to traffic such portions of the project and temporary roadways or portions thereof as may be agreed upon between the Contractor and the Engineer for the temporary accommodation of traffic during the anticipated period of suspension. Thereafter, and until an issuance of an order for the resumption of construction operations, the maintenance of the temporary route or line of travel agreed upon will be by and at the expense of the Department. Such maintenance and responsibility will include and be restricted to the traveled roadway for the convenience of public travel; opening plugged pipes and roadway ditches and drains; or correcting any other hazard which may be detrimental to adjacent property owners or the traveling public. When work is resumed, replace, renew, and repair any work or materials lost or damaged because of such temporary use of the project regardless of the cause of such damage or loss, except as provided in Subsection 107.15. The Department is in no way responsible to maintain the roadway and appurtenances in any certain condition or state of repair. Complete the project in every respect as though its prosecution had been continuous and without interference.

Maintain public traffic throughout the project by approved methods. Public traffic includes motor vehicles, bicycles, and pedestrians. Pedestrian access shall be the width of the existing sidewalk and shall be ADA compliant. Allow access and passage of bicycle traffic in the travel lanes where bicycle and motor vehicle traffic must share the same lanes. When an approved plan to accomplish this is provided in the contract documents, alternate proposals for handling public traffic through the project may be submitted, and are subject to approval. Furnish alternate proposals containing sufficient detail to determine the appropriate number and placement of traffic control devices. Should approval of an alternate proposal result in additional costs, these costs shall be borne by one of the following:

(a) The Contractor, when proposed change is deemed by the Engineer to be for sole benefit of the Contractor.
(b) The Department, when the proposal is in the best interest of the Department and/or the traveling public.
(c) Both the Contractor and Department, by a negotiated amount, when proposed change is beneficial to both.

Consideration will be given to each such proposal and may be rejected, modified, or accepted as deemed best. Do not proceed with any such change in the staging until permission is granted in writing. Rejection of the Contractor's proposed alternate traffic control plan shall not be considered sufficient cause for additional compensation or an extension of contract time.

Provide and maintain in a safe condition temporary access to business and residence driveways, temporary intersections, and temporary connections with roads, streets, bikeways, sidewalks, and footpaths.

For traffic control limitations see Subsection 108.04.

Existing speed limits shall remain in effect unless written approval is given by the Department.

Comply with all the traffic control requirements shown on the Standard Plans and Traffic Control Plan Sheets.

Install and remove all traffic control devices in accordance with the restrictions as specified herein.

Initial deployment of construction signs and traffic control devices on shoulders may not occur more than 24 hours in advance of work activities.

The project superintendent shall verify with the Engineer that necessary labor, equipment and materials for the planned work activities are on site prior to placing traffic control devices. Do not begin placing traffic control devices until necessary labor, equipment and materials are on-site to perform planned work activities.

Place work zone traffic control for the anticipated work shift activities. Move tapers ahead throughout the shift to ensure that the lag behind work activities does not exceed 1.6 km (1 mi). Adjust speed reduction signs with work zone and cover or remove when no longer appropriate.

Upon completion of a specific work activity or item as identified in the project schedule, remove traffic control devices from the project roadway and stockpile at an approved staging area if subsequent work is not scheduled in the same project phase, stage, or location within 5 working days (or 7 calendar days for calendar day or completion date projects). In addition, prior to holidays or special events, remove all traffic control devices which no longer apply to existing conditions, as directed. Traffic control devices must be removed from the roadway and stockpiled a minimum of 9 m (30 ft) from the pavement edge at an approved staging area.

During non-working hours, place a traffic cone immediately in front of any construction sign that is located within 3 m (10 ft) of the travelway and whenever practical, move the traffic control signs from the plantmix surface onto the gravel shoulder.

Place and remove construction signs and traffic control devices daily for striping operations. Stockpile signs and devices a minimum of 9 m (30 ft) from the pavement edge at an approved staging area.

Do not remove guideposts until final shouldering-up operation. Install new guideposts within 24 hours of removal. If a guidepost is damaged during preliminary shouldering-up operations, replace it in like kind within 24 hours.

Cover “Double Penalty,”“Begin Work Zone,” and “End Work Zone” signs during non-working hours.

After presumptive completion of all pay items and at such time as contract time is suspended for final clean up, as defined in Subsections 104.05 and 108.09, remove all traffic control devices daily from the roadway and stockpile a minimum of 9 m (30 ft) from the pavement edge at an approved staging area. All traffic control devices necessary for final clean up work shall be placed and removed from the project right-of-way on a daily basis.

Failure to comply with any of the requirements specified herein will be considered a traffic control deficiency and subject to the liquidated damages as specified below.

If two violations of the traffic control requirements specified herein are observed by the Engineer, work may be suspended. If work is suspended, submit a written revised construction plan, which addresses the deficiencies. Upon written approval of the plan, the construction operations may resume. Working days, or calendar days, will continue to be assessed during the suspension period.

Allow emergency vehicles immediate passage. Notify police and fire departments having jurisdiction over the project when traffic patterns are to be altered due to construction operations. Give such notification in writing with a copy to the Engineer, and except in extreme emergencies, submit the notice at least 24 hours in advance of rerouting public traffic. The notification shall set forth the specific traffic patterns to be provided in lieu of normal routing and the estimated duration of such change(s) together with such additional information which will contribute to the general safety of the public as determined.

Except as hereinafter provided, maintain access to properties abutting the right of way in a manner closely approximating existing access unless otherwise shown on the plans or directed. When access to private driveways must be temporarily denied due to construction operations such as the installation of storm drains, sidewalks, curbs and gutters, etc., notify the property owner or responsible party of such closure not less than 24 hours in advance of closure. Give the notification in writing and include the estimated duration of the closure.

When equipment is crossing or using any portion of the travelled way over which public traffic is directed, clean up and remove all debris dropped by the equipment at frequent intervals as directed.

Notify adjacent residents, homeowners, businesses, and schools along each side of the project limits that are being affected by construction work and disruption of normal traffic patterns. Written notification shall be distributed at least 20 days prior to commencing work. The notification shall include, but not be limited to, the approximate work schedule, road closures, detours, delays, suggested alternate routes, and description of traffic control. Submit the notification for approval 7 days prior to distribution.

In the event a routine traffic control deficiency, including maintenance of traffic control items, is not corrected within 2 hours after notification, a deduction in the amount of $100.00 per deficiency per device will be made from monies due for each 15 minute increment the deficiency remains, not as a penalty, but as liquidated damages. Failure to address the deficiency may also be cause for withholding progress payments and suspension of work until the issue is resolved.

**624.03.02 Detours.** Construct detours as shown on the plans or as specified. Exact location will be as staked.

Grading shall consist largely of motor grader work, supplemented where necessary by other mechanical equipment. Grade to provide the specified roadbed width and a grade line free from breaks or rolls of sufficient magnitude to be hazardous to traffic.

If required, after the grading has been satisfactorily completed, place surfacing materials of the kind and type specified, by the requirements for the particular materials used.

Apply water to detours in amounts necessary to attain compaction of graded sections and surfacing materials.

Maintain detours by filling holes as they develop, adding surfacing and applying cutback asphalt, blading, watering, and performing any other work necessary to maintain the detour satisfactorily.

Eradicate detours when no longer needed. Eradicate so that the ground will be restored as nearly as feasible to the original condition, and dispose of materials as directed.

To request a detour, submit a written request for the establishment of a detour around all or certain designated sections of work. If arrangements for such a detour can be made which are satisfactory to the Department, the Contractor, and the governmental agency having jurisdiction over the road to be used, the road will be designated as a detour, subject to the following conditions:

1. Provide and maintain the necessary route marking signs.
2. Construct and maintain the detour in good condition. Failure to maintain the detour in such a satisfactory condition, will cause the Department to make such repairs as is deemed suitable and deduct the cost thereof from money due or to become due.
3. When abandoning the detour, obliterate and dispose of such detour and satisfactorily restore as nearly as possible the condition of the ground to its original form.

**624.03.03 Flaggers.** Employ flaggers at places as designated. Use additional flaggers, at own expense, whenever seeing fit to do so.

Flaggers shall have completed an approved instructional course in flagger procedures. Prospective flaggers shall possess a valid flagger card attesting that they have satisfactorily completed said instructional course conducted by the Department or some other course approved by the Department.

Personnel who attend an approved instructional course in flagger procedures shall be a minimum of 18 years of age and shall be able to clearly communicate.

The time required to instruct employees who are proposed flagger candidates will be reimbursed as follows:

(a) Attendance must be to a course approved by the Department.
(b) Employee must be on the Contractor’s payroll for the hours of reimbursement.
(c) Reimbursement will be for the actual instruction period required or a maximum of 4 hours, whichever is less.
(d) Reimbursement shall be at the contract unit price bid per hour for flagger.

Supply each flagger with an orange or yellow green hard hat and an orange or yellow green soft cap. Use of hard hats is mandatory in any area designated by the Contractor or the Engineer as a hard hat area.

Flaggers shall use a combination “STOP” and “SLOW” sign paddle. The paddles shall be a minimum of 450 mm (18 in.) wide, with 150 mm (6 in.) series “C” letters and have a rigid fixed handle approximately 1.5 m (5 ft) in length, from the bottom of the paddle to ground level. Fabricate the combination sign paddle from sheet metal or other light semirigid material. The background of the “STOP” face shall be red with white letters and border. The background of the “SLOW” face shall be fluorescent orange with black letters and border. Use Type IX or XI reflective sheeting conforming to Subsection 716.03.01 for the background, letters, and borders on the faces of the Stop/Slow paddles.

Adequately illuminate flagger stations at night at own expense. Use flood lights, approved by the Engineer, to illuminate flagger stations.

During daytime operations, flaggers shall wear vests meeting Vest Pattern 3 (Performance Class 2) requirements set forth in ANSI/ISEA 107-2004 “American National Standard for High-Visibility Safety Apparel and Headwear” and the requirements specified herein.

During nighttime operations, flaggers shall wear either jackets or coveralls/jumpsuits meeting Performance Class 3 requirements set forth in ANSI/ISEA 107-2004 and the requirements specified herein. These garments are optional for daytime use.

The color of the background material shall be fluorescent yellow-green. Stripes shall consist of retroreflective material of a contrasting color of silver, white, or fluorescent yellow-green.

The apparel shall bear the manufacturer’s marking label according to the requirements set forth in ANSI/ISEA 107-2004.

Furnish certificates of compliance executed by the manufacturer’s of such high visibility work zone apparel attesting that the garments furnished meet the specifications described herein.

**624.03.04 Pilot Cars.** Use a pilot car and driver when directed.

Pilot cars shall be suitable vehicles in good mechanical condition and shall carry a sign which complies with the design shown in the “Standard Highway Signs” manual. All pilot car drivers must have a valid flagging card.

**624.03.05 Equipment Rental.** Use equipment rental for incidental construction as directed or as indicated on the plans.

Equip all equipment rented with buckets, scrapers, and other required accessories that do not exceed the power unit manufacturer’s recommended maximum capacity for the particular power unit involved.

Equipment shall conform to the following minimum requirements:

| | |
|---|---|
| Motor Grader | 75 kW (100 h.p.), Blade Length 4.2 m (14 ft) |
| Loader | 3.8 $m^3$ (5 $yd^3$) Capacity |
| Dump Truck | 9 $m^3$ (12 $yd^3$) Struck |
| Rubber-Tired Tractor with Scraper | 215-260 kW (290-350 h.p.) with Manufacturer’s Rated Capacity Scraper, equip tractor with all necessary accessories to operate scraper |
| Tractor-Crawler with Dozer and/or Ripper | Manufacturer’s Rated 275 kW (370 h.p.), equip tractor with all necessary accessories to operate bulldozer and ripper |
| Elevating Scraper | 120 kW (160 h.p.), 7.6 $m^3$ (10 $yd^3$) Struck, fully equip with all accessories for scraper operations |
| Backhoe | 60 kW (75 h.p.), equip with front end loader and all necessary back accessories to operate hoe and front end loader |

Use approved equipment in good operating condition.

**624.03.06 Traffic Control Supervisor.** Designate a traffic control supervisor who shall be responsible for initiating, installing and maintaining all traffic control devices as shown on the plans, as specified in the MUTCD and these specifications, or as directed. The persons so designated shall have at least one year of experience directly related to worksite traffic control in a supervisory or responsible capacity and shall be certified as a worksite traffic supervisor by ATSSA. Submit the name and qualifications of this person 7 days in advance of the date set for the preconstruction conference in order to review said qualifications.

The traffic control supervisor shall be an employee of the Contractor, under the direct supervision of the Superintendent, and dedicated solely to the contract.

The traffic control supervisor shall be available to be contacted by the Engineer 24 hours a day for the life of this contract and shall be capable of being on-site within 45 minutes of notification. The traffic control supervisor shall make at least 4 inspections of all traffic control devices each day as follows:

1. Before beginning work.
2. At mid-shift.
3. Half an hour after the end of the shift.
4. A minimum of once during the period of non-working hours. The time between inspections shall not exceed 12 hours.

The traffic control supervisor shall make a record of each traffic control inspection using the Department furnished "Work Zone Traffic Control Checklist," Form # 040-056B. Each review shall include traffic control activities, the time the traffic control supervisor reviewed the traffic control, any actions taken, and any other pertinent information. Submit completed forms within 24 hours.

## METHOD OF MEASUREMENT

**624.04.01 Measurement.** Construction, maintenance, and removal of detours will be measured under appropriate bid items as indicated herein and on the plans.

Flaggers will be measured by the number of hours that authorized flaggers are actually used to direct traffic within the right of way limits of the project, or at points where hauling equipment enters and leaves the public traffic stream while hauling from deposits (except commercial sources), outside or within the project limits, as approved.

Traffic control supervisor will be measured by the day, for each eligible working day assessed to the contract, not to exceed the number of working days specified in Subsection 108.02, plus or minus any authorized changes.

Pilot car will be measured by the number of hours that the pilot car and driver are actually used.

Rent equipment will be measured by the number of hours actually used.

## BASIS OF PAYMENT

**624.05.01 Payment.** The accepted quantities, measured as provided above, will be paid for at the contract price per unit of measurement for the pay items listed below that are shown in the proposal. Payment will be full compensation for the work prescribed in this Section.

When a traffic control plan is furnished by the Department as part of the bid documents and the items of flaggers or pilot car do not appear in the proposal, then one or both of these items are deemed necessary, furnish flaggers or pilot cars and payment therefore will be made according to Section 104.

Payment will be made under:

| Pay Item | Pay Unit |
|---|---|
| Detours | Appropriate Bid Items or Force Account |
| Flagger | Hour |
| Traffic Control Supervisor | Day |
| Pilot Car | Hour |
| Rent Equipment (type) | Hour |

# SECTION 625

## CONSTRUCTION SIGNS

DESCRIPTION

**625.01.01 General.** This work consists of furnishing, maintaining, relocating, and removing temporary traffic control devices and services as ordered for the control and protection of public traffic through the project.

This work also consists of rent traffic control devices, which includes designing traffic control plans and furnishing and placing traffic control devices meeting the requirements of this Section and Section 624.

MATERIALS

**625.02.01 General.** Low mass, single piece traffic cones, tubular markers, single piece drums, and delineators without attachments are considered as Category 1 devices as defined in NCHRP Report 350. Furnish certificates of compliance executed by the manufacturer's of such Category 1 devices, attesting that they have supporting certification (crash tests and/or engineering analysis) that they meet the evaluation criteria of NCHRP Report 350.

Use barricades, portable sign supports, and cones or drums with attachments, which meet National Cooperative Highway Research Program (NCHRP) Report 350 testing criteria for Category 2 Devices, which have been accepted by FHWA, and meet NDOT Specifications.

Typically these devices will be the Type I, II, and IIIB barricades, and construction signs mounted on portable supports for short-term, short-duration, and mobile conditions. Note that a sign together with its portable support is considered as a system, which together must meet the NCHRP Report 350 requirements. Furnish certificates of compliance executed by the manufacturer's of such Category 2 devices, even though listed in the QPL. This certification shall attest that the models furnished are the same as the ones tested and accepted by FHWA.

Construct sign panels of steel, aluminum, wood, or other approved material of a sound, durable nature. The materials shall be of such quality to do the job for which they are intended and are subject to approval. Repair or replace signs which are dirty, dull, have flaking or peeling reflective sheeting, or are otherwise marred.

The traffic drums shall be the two piece plastic break away design type. Close or seal the drums to prevent the ballast from getting wet and freezing.

Equip arrow boards to be used at night with a photoelectric sensor for automatic dimming of the lamps during darkness, to a minimum of 50% of their rated lamp voltage.

Flexible sign panels that comply with NCHRP Report 350 may also be used provided their support frames hold the panel surface relatively smooth.

All signs, barricades, drums, vertical panels, traffic cones, delineators, barricade warning lights, and arrow boards shall also conform to the MUTCD, the Standard Highway Sign Book, including the Nevada Supplement thereto, unless indicated otherwise on the plans or the Special Provisions.

All rented traffic control devices will also be subject to being rated for conformance to the current American Traffic Safety Services Association (ATSSA) publication "Quality Standards for Work Zone Traffic Control Devices" which is available from American Traffic Safety Services Association, 5440 Jefferson Davis Highway, Fredericksburg, VA 22407, phone (703) 898-5400. Replace any device not meeting these quality standards with an acceptable device.

Rented portable precast concrete barrier rail shall conform to Sheet R-8.7.1 of the Standard Plans and the applicable requirements of these specifications.

Furnish rented portable precast concrete barrier rail with a smooth and uniform appearance. The barrier rail shall be true, straight, and free of lumps, sags, and other irregularities. When a straight edge 3.6 m (12 ft) long is laid on top of the barrier rail, the surface shall not vary more than 6 mm (1/4 in.) from the edge of the straight edge. When a straight edge 3.6 m (12 ft) long is laid along the face of the barrier rail, the surface shall not vary more than 12.5 mm (1/2 in.) from the edge of the straight edge. Allow inspection of the barrier rail prior to delivery.

**625.02.02 Reflectorization.** Reflectorize construction signs, barricades, drums, cones, and vertical panels with Type IV, Type V, Type VI, Type IX, or Type XI reflective sheeting conforming to Subsection 716.03.01.

The orange reflective sheeting used on rigid construction signs shall be Type IX or Type XI fluorescent orange sheeting.

The orange reflective sheeting used on roll up construction signs shall be Type VI fluorescent orange sheeting.

The orange reflective sheeting used on drums and cones shall be Type IV or better fluorescent orange sheeting.

Keep reflective sheeting on traffic control devices clean. Promptly correct scratches, rips and tears in the sheeting. Maintain sheeting retroreflection of not less than 50% of the minimum Coefficient of Retroreflection values required in Subsection 716.03.01.

The markings on the drums shall be horizontal, circumferential, orange and white reflectorized stripes as shown in the Standard Plans.

Paint portable precast concrete barrier rail white with paint conforming to Subsection 714.03.03.

Place a two way reflector on top and in the center of each portable precast concrete barrier rail section. When using water filled barrier rail, place two way reflectors on top of the rail at a maximum spacing of 6 m (20 ft). Color of the reflectors shall conform to the MUTCD. Use reflective markers listed in the QPL.

**625.02.03 Changeable Message Signs.** The changeable message signs shall be transportable truck or trailer mounted programmable message signs.

The message sign boards shall be capable of displaying 3 lines of message text, each with 8 characters of 5 x 7 font of 300 mm (12 in.) minimum height, formed by a bulbtype, LCD, LED, or electromagnetic disk matrix. At nighttime the sign display shall be self illuminated.

Program the changeable message signs as instructed by the Engineer. Supply the Engineer with a programming manual for informational purposes.

Use changeable message signs listed in the QPL.

**625.02.04 Temporary Impact Attenuators.** The temporary impact attenuators shall be approved for speeds up to the design speed shown in the contract documents.

Furnish all manufacturers shop drawings, installation instructions and any other pertinent information before installation.

Use temporary impact attenuators listed in the QPL.

**625.02.05 Truck-Mounted Impact Attenuators.** Furnish and install the truck-mounted impact attenuators with all parts and materials necessary for them to perform as designed. Attach the truck-mounted impact attenuators to the back of the trucks according to the manufacturer's attachment details.

Furnish a highway maintenance service type truck of the proper weight and equipped with a Type C arrow board with each truck-mounted impact attenuator. For stationary operations, set the truck's parking brake and put the transmission in second gear. Equip the truck with shoulder and lap restraint safety belts for both driver and passenger seats.

Equip the truck-mounted impact attenuators with rear-mounted black and high intensity yellow chevron stripes and a standard trailer lighting system, including brake lights, turn signals and 2 yellow rotating beacons mounted on opposite rear corners of the truck at approximately 1.4 m (4.5 ft) from ground level.

Keep the truck-mounted impact attenuators bright and clean for maximum visibility.

Use truck-mounted impact attenuators listed in the QPL.

**625.02.06 Water Filled Barrier Rail.** Water filled barrier rail may be substituted for the rented portable precast concrete barrier rail required for the contract, when the regulatory speed limit is appropriate and when approved.

Install the water filled barrier rail in accordance with the manufacturer's recommendations. Furnish all manufacturer's shop drawings, installation instructions, and any other pertinent information prior to installation.

Properly install the water filled barrier rail and fill with water prior to beginning work in the area protected by the rail. Avoid spillage of water from the water filled barrier rail on the traveled way at all times.

Use water filled barrier rail listed in the QPL.

**625.02.07 Portable Beacon Light Systems.** The flagger stations for stopping traffic at each end of work zones, which require one way traffic control operations, may be supplemented by the use of a portable beacon light system. Place the beacon light system near the flagger station, outside of traffic flows, and in a visible location.

The beacon light system shall have a clear warning beacon strobe light on top, a 200 mm (8 in.) diameter red light for stopping traffic, and a 200 mm (8 in.) diameter yellow light for allowing traffic to proceed with caution.

The beacon light system shall have a remote control for the lights' operation by the flagger at a distance of up to 30 m (100 ft) and operate on a portable 12 volt power supply.

The beacon light system shall be portable and lightweight, yet stable under moderate winds and traffic caused wind gusts.

The lights shall be mounted on an adjustable support at approximately 3 m (10 ft) from the bottom of the base to the top of the beacon.

Manufacturers of portable beacon light systems are listed in the QPL.

## CONSTRUCTION

**625.03.01 General.** Place all necessary traffic control devices before any detour or temporary route is opened to traffic.

Install and maintain traffic control devices according to the approved traffic control plan, Nevada Work Zone Traffic Control Handbook, and the MUTCD. Relocate temporary traffic control devices as necessary. Remove devices that no longer apply to the existing conditions.

Do not remove any traffic control devices from the project until approved.

Immediately after removing guide posts, place and maintain traffic cones at each guide post location until the new guide posts are installed. Traffic cones will not be required at guide posts removed behind guardrail.

When a pay item is not provided for traffic cones in the proposal, the cost of furnishing, placing, maintaining, and removing of the traffic cones before installation of the new guide posts shall be considered as included in the price paid for other items of work.

Certain signs may require covering during the progress of the work. Covers shall completely block out the message during the day or night. Do not use burlap or similar fabrics. Fasten covers securely to prevent movement by wind action and withstand the effects of weathering. Do not apply adhesive tape to the face of a sign.

After completion of construction activities and before final acceptance of this project, provide covers to all project construction signs as directed.

Install temporary impact attenuators at locations as shown on the plans according to manufacturer's recommendations and as directed.

**625.03.02 Sign Placement.** Place signs in positions where they will convey their messages most effectively without restricting lateral clearance of sight distance. Placement must therefore accommodate highway design and alignment.

**625.03.03 Sign Supports.** Construct signs, posts, and their foundations so as to hold signs rigidly in a proper and permanent position, and prevent them from swaying in the wind, or from being turned or otherwise displaced by irresponsible persons.

A portable or removable type of mounting may be used for signs required intermittently or which are frequently moved. Such a mounting shall be heavy enough not to turn over in the wind, and its base shall not be appreciably wider than the sign. Use portable sign supports listed in the QPL.

Fixed supports for signs shall conform to the requirements for ground mounted sign supports in Section 627 and as shown in the plans for permanent signs.

**625.03.04 Barricades.** Protect highways closed to traffic by barricades, or portable precast concrete barrier rail as approved. Provide and maintain appropriate warning and detour signs at all closures, intersections, and along detour routes. Direct the traffic around the closed portions of the highway so that the temporary detour routes are clearly indicated throughout their entire length.

Use barricades listed in the QPL.

Do not use rocks, asphalt or concrete pieces, construction materials, and other debris as weighting devices for barricades or drums. Sand bags will be permitted as long as a low center of gravity is maintained as approved.

**625.03.05 Contractor Designed Traffic Control Plans.** Design traffic control conforming to the latest edition of the MUTCD, the Standard Plans, and as specified herein.

Submit four copies of the proposed traffic control plan no later than 7 days before the Preconstruction Conference. The proposed traffic control plan shall be prepared and/or certified as to conformance with the above by a Professional Traffic Operation Engineer (PTOE) or an ATSSA certified Work Site Traffic Supervisor and shall include the PTOE registration number or ATSSA certification number of the certifying person.

Failure to submit the traffic control plan within the above time frames will not be justification for delaying the Notice to Proceed nor for additional working days. Failure to adequately address comments in any required resubmittal also will not justify additional working days.

For projects requiring multi-phase traffic control plans, only the initial phase must be submitted according to the above time frames. However, submit any future phases of the traffic control plans a minimum of 21 days before commencement of that construction phase to allow for review and resubmittal as necessary. Do not begin construction on any given phase before receiving written acceptance of the traffic control plan for that phase.

Any days lost due to improper traffic control will be charged against the allowable working days.

The traffic control plan shall include, but not be limited to the following:

(a) Proposed construction zone and existing speed limits.
(b) All construction signs, including side streets signing.
(c) Types and location of traffic control devices, and a summary of the quantity of devices necessary for each phase.
(d) Location of flaggers and uniformed traffic control officers.
(e) Temporary striping.
(f) Construction phasing (including phasing of intersection construction and detours, if any).
(g) Lane cross-overs between construction phases.
(h) Method for maintaining traffic signal functions.
(i) Special events scheduling.
(j) Detours.
(k) Private property and business access plans.
(l) Accommodation of pedestrian, bicycle, and transit facilities.
(m) Lane and shoulder widths.

The initial submittal will be reviewed and written comments and/or corrections to the plan, if any, will be provided at the Preconstruction Conference. If necessary, the Contractor and Engineer will meet to consider the comments and/or corrections to the plan at the Preconstruction Conference to resolve any issue relative to the traffic control

plan. Resubmit the final traffic control plan within 7 days after receipt of review comments to the proposed traffic control plan. Upon resolution of all issues or acceptance of the traffic control plan as submitted, the plan will be accepted in writing by the Department.

During construction the Engineer may require revisions to the accepted plan as necessary for safety or accommodation to traffic.

Submit in writing, accompanied with drawings, any requests to change the traffic control plan a minimum of 7 days before commencing work. Have the proposed changes to the traffic control plan prepared and/or certified the same as specified herein for the initial traffic control plan. Such request must be accepted in writing before implementation. Additional working days will not be considered for delays associated with review and acceptance of requested changes.

Acceptance of the submitted traffic control plan, shall in no way relieve the Contractor of the responsibility for safety requirements. Such acceptance shall in no way be construed as confirmation of the technical accuracy or adequacy of the contents of the plan and shall not relieve the Contractor of the obligation to institute traffic control measures in full compliance with contract requirements, and which function safely and correctly, and are in conformance with applicable statutes, ordinances, and regulations.

Within 48 hours after installation of new or modified traffic control, inspect the controls installed in the field to determine if all required controls have been installed and are operating as intended. Submit a signed affidavit stating that the traffic control has been inspected and is found to be in conformance with the accepted traffic control plans and contract requirements. If it is determined that the traffic controls are not in conformance with the accepted traffic control plans or contract requirements, correct immediately. If the accepted controls do not provide a safe and efficient construction zone, recommend revisions to address these deficiencies, in writing. If during the course of construction the traffic control is determined to have been modified or is not functioning as intended, the Contractor may be directed to reevaluate the traffic controls and make revisions as necessary.

Submit a draft of residence and business general project information notification letters for approval before distribution of the notices. Submit a final copy of all written notifications before distribution.

Prepare and distribute general project information notices to all residences and businesses adjacent to the project to ensure that residences/businesses receive the notice no less than 7 days before beginning any construction. The notice shall include the following:

(a) General scope of project (description of project and limits, hours and days of operation, phasing information, lane closure, parking restrictions, etc.).
(b) Access plans.
(c) Contractor contact and telephone number.
(d) Other appropriate information requested by the Engineer.

In addition to the general project information notices, prepare written notification of commencement of construction on any new segment of the street. Distribute these notices to adjacent residences/businesses within the new construction segment a minimum of 2 working days before commencing work in the new street segment. Submit a draft of the notice for acceptance before distribution.

Upon approval of the traffic control plan, and not less than 2 working days before beginning construction, notify local police and fire departments and any other emergency service of the upcoming construction.

During the course of construction, be prepared to provide access through the construction zone for police, fire or emergency vehicles which otherwise do not have through access due to traffic tie-ups and the inability to pass without entering the construction zone.

Do not proceed with any construction until traffic control plans have been accepted and the proper traffic control has been provided.

Design and construct any detours, lane crossovers, or other appurtenances which are required for the implementation of the traffic control plan. Remove these same detours and appurtenances and restore the area to original condition or better upon completion of the work which originally required them. The cost of this design, construction, removal and restoration shall be included in the contract price for the Rent Traffic Control Devices pay item and no additional compensation will be allowed therefore. Contact and obtain written approval from the owner of any lands on which a detour is proposed, before implementation of said detour.

Provide flaggers or signals at intersections within the construction zone to direct traffic movements at all times during construction at the intersections. During non-working hours, control the intersection with normal signal pattern or by some other approved method. Coordinate with and secure approval from the appropriate agencies for any use of or changes to operation of existing traffic signal equipment in the traffic control plan operation. On occasions when flagger control is necessary for safety or efficient traffic flow within signalized intersections, turn the signal off. Do not use the flaggers to control the intersection with the signal in operation. If flaggers enter the intersection to control traffic, equip them with proper attire and control devices. The number of flaggers and equipment/attire shall comply with applicable MUTCD, State, and local requirements. Illuminate flagger stations at night from the vehicle approach direction.

Whenever operations create a condition hazardous to traffic or to the public, furnish such devices as are necessary to give adequate warning to the public of any dangerous conditions to be encountered. Furnish, erect, and maintain such fences, barricades, lights, signs, channelization devices, temporary pavement striping, arrow boards, detours, and other devices as are necessary to prevent accidents and avoid damage or injury to the public until all permanent traffic control striping, signs and devices are installed and operational and the project is accepted.

If after notification of hazardous traffic conditions and failure to furnish and/or maintain warning and protective devices as required, the State may furnish and/or maintain such devices and charge the Contractor by deducting the cost thereof from periodic progress payments due the Contractor as such costs are incurred by the State.

Do not use Type I or Type II barricades to prevent vehicle traffic from entering a closed portion of roadway. Use only Type IIIB barricades in all such instances. Place Type IIIB barricades used for this purpose a maximum 1.2 m (4 ft) apart. Yellow warning lights may be necessary for some barricade or drum applications.

Delineate and sign all longitudinal drop-offs greater than 25 mm (1 in.) exposed to public traffic.

Protect public traffic from longitudinal drop-offs greater than 100 mm (4 in.) with an approved barrier or construct and maintain approved 1:6 (6:1) maximum safety slopes.

In areas with pedestrian traffic, use fencing around open trenches. The fencing may be placed on top of portable concrete barrier rails.

Maintain a minimum of 12 foot lanes and 2 foot shoulders unless otherwise approved.

Use temporary painted striping, striping tape, or reflective lane line markers to delineate temporary traffic lanes or mark other required patterns or symbols. Temporary painted striping may only be used on pavement which is to be replaced or overlaid as part of the contract.

Temporary painted striping shall conform to Section 636.

Temporary striping tape shall conform to Section 635.

Temporary reflective lane line markers shall conform to Section 633.

Effectively remove, at no direct payment, any existing lines or markings of paint, tape, film, or pavement markers that conflict with the required temporary lines. Remove such lines in a manner so as to leave no residue or other trace of the former line that may be misconstrued by a driver to be a traffic line under any condition of daylight, darkness, or wetness of pavement.

## METHOD OF MEASUREMENT

**625.04.01 Measurement.** Construction signs will be measured for rental by the square meter (square foot) of sign surface.

Traffic cones, drums, barricades, barricade warning lights, arrow boards, and vertical panels will be measured for rental by the each.

Portable precast concrete barrier rail and water filled barrier rail will be measured for rental by the linear meter (linear foot). The quantity of barrier rail shown on the contract proposal is deemed sufficient for the construction of this project. If electing to stage construction so as to require additional barrier rail, furnish and place said additional rail with no additional compensation.

Barrier rail will be measured for payment one time only and that movement to another location will not be grounds for remeasurement. However, should additional lengths be required over and above the length first measured, such additional lengths will be measured for payment.

Changeable message signs will be measured for rental by the each or day.

Temporary impact attenuators will be measured for rental by the each.

Truck-mounted impact attenuators will be measured for rental by the each or day, including the truck with arrow board.

Only the quantity and type of traffic control devices shown in the proposal which are ordered or approved in writing for delivery to the project will be measured for payment. Such order or approval will not be given until after providing the proposed method of operation.

Rent traffic control devices will be measured by the lump sum, which includes furnishing a traffic control plan, providing flaggers, pilot cars, traffic control supervisors, or constructing, maintaining and removing detours, furnishing and installing all construction signs, traffic cones, traffic drums, vertical panels, removal of striping, temporary pavement striping, barricades, barricade warning lights, arrow boards, impact attenuators, changeable message signs, barrier rail, or other traffic control and safety devices not listed as separate bid items in the proposal.

BASIS OF PAYMENT

**625.05.01 Payment.** The accepted quantities, measured as provided above, will be paid for at the contract price per unit of measurement for the pay items listed below that are shown in the proposal. Payment will be full compensation for the work prescribed in this Section.

Partial payment for rent traffic control devices will be made according to Subsection 109.06.

Signs which have been measured for payment as set forth in Subsection 625.04.01 but were not erected will be paid at the rate of 60% of the contract unit price bid.

Moving traffic control devices from one location to another on the contract, as directed, shall be considered necessary and essential and no additional compensation will be allowed therefore.

No additional compensation will be allowed for rent traffic control devices by the lump sum, unless a bid item requiring traffic control qualifies as having a “significant change” in the character of work as specified in Section 104. In such cases the payment for extra work for traffic control will be determined according to Section 109.

Payment will be made under:

| Pay Item | Pay Unit |
|---|---|
| Rent Construction Signs | Square Meter (Square Foot) |
| Rent Construction Barricades (type) | Each |
| Rent Portable Precast Concrete Barrier Rail | Linear Meter (Linear Foot) |
| Rent Water Filled Barrier Rail | Linear Meter (Linear Foot) |
| Rent Traffic Cones | Each |
| Rent Barricade Warning Lights (type) | Each |
| Rent Arrow Board (type) | Each or Day |
| Rent Traffic Drums | Each |
| Rent Vertical Panels | Each |
| Rent Changeable Message Signs | Each or Day |
| Rent Temporary Impact Attenuators | Each |
| Rent Truck-Mounted Impact Attenuators | Each or Day |
| Rent Traffic Control Devices | Lump Sum |

# SECTION 627

## PERMANENT SIGNS

### DESCRIPTION

**627.01.01 General.** This work consists of furnishing, erecting, and installing signs, sign supports, and other materials required for highway signs.

**627.01.02 Shop Drawings.** Furnish 5 sets of shop drawings for each overhead sign structure for approval.

Do not fabricate overhead sign structures until the shop drawings have been approved.

For signs which are shown on the sign summary sheets and are not included in the Standard Highway Sign Book or the Nevada Supplement, the Department will furnish special sign design sheets. Fabricate these signs to conform to the special sign design sheets as well as the drawings noted in the plans.

### MATERIALS

**627.02.01 General.** Material shall conform to the MUTCD, the Standard Highway Signs (FHWA), the Standard Highway Signs (Nevada Supplement), and the following Section:

Sign Materials ..... Section 716

Sign panels of sizes 900 mm by 900 mm (36 in. by 36 in.) or smaller, which are mounted on a single post, may be constructed of ultraviolet resistant engineered thermoplastic.

Manufacturers of thermoplastic sign panels are listed in the QPL.

**627.02.02 Reflectorization.** Use Type IV, IX, or XI reflective sheeting material for regulatory and ground mounted guide sign installations.

Use Type IV reflective sheeting for background material and Type IX or XI reflective sheeting for legend on overhead guide sign installations.

Use Type IX or XI fluorescent reflective sheeting for warning sign installations.

Reflectorized signs made of molded thermoplastic material shall meet the requirements for Type IV reflective sheeting.

Overlay acrylic EC films and inks used for assembly shall be approved for use by the manufacturer of the sheeting material. Use only acrylic EC film to achieve color. The service life of inks and films shall be comparable to the sheeting used.

All letters, numerals, symbols, borders, and accessories as necessary for the sign legend shall be directly applied to the sign background or molded to form an integral sign legend and background on all signs.

### CONSTRUCTION

**627.03.01 Panel Fastenings.** Provide the panel sections with suitable fastenings, as shown on the plans, to permit easy attachment to the supporting frames.

Provide panel sections with closure strips at the joints.

Panel fastenings shall utilize nylon washers for contact between the reflective sheeting and the metal washer.

Pre-paint the exposed portion of fastening hardware on the face of the sign panels with baked enamel or use a commercial quality pre-painted fastener to match the sign face.

**627.03.02 Closure Strips.** Closure strips are required on aluminum sign panels. Anchor closure strip by aluminum rivets or approved alternate, colored to match the sign face.

**627.03.03 Installation.** Sign locations indicated on the plans are approximate only. Final determination of sign locations will be made in the field.

Construct sign islands as roadway embankment according to Section 203, unless otherwise specified. Structure excavation and backfill shall conform to Sections 206 and 207. Sign illumination systems shall conform to Section 623.

Construct footings according to Section 502. Set anchor bolts true to line and grade. Set posts plumb.

Construct overhead sign pile foundations according to Section 509.

Permanently stamp the date of installation, consisting of month and year, on the back of each sign with metal dies. In lieu of a stamped date, the date may be applied by the use of an electrical engraving tool. Make date visible only on close inspection. Place the date on the lower right hand corner when facing the rear of the sign. Apply the stamped date in a manner as not to damage the face of the sign.

Clean each sign face according to the reflective material manufacturer's recommendations. Remove all undesirable material that is visible on the face. Do not use abrasives or other cleaning materials that will scratch or otherwise deface the face.

Directional signs that are not functional may require covering during the progress of the work. Covers shall be of sufficient size and density to completely block out the message so that it is not visible either during the day or night. Do not use burlap or similar fabrics. Fasten covers securely to prevent movement by wind action and withstand the effects of weathering. Do not apply adhesive tape to the face of a sign.

Cover messages on sign faces of all directional signs facing public traffic and directing such traffic to a portion of the project not yet open to public traffic.

Exercise care at all times in the handling, storing, transporting, and erecting of the signs. Repair or replace signs which are damaged.

Pipe sign posts may be field cut and drilled to adjust for local conditions when approved. Do not flame cut. Clean all field cuts and abraded areas on steel pipe posts and apply 2 coats of paint having a high zinc dust content conforming to MIL-P-21035.

Do not extend the lengths of sign posts by splicing or welding.

**627.03.04 Removal.** This work consists of removal of existing permanent sign panels, posts, footings, and overhead sign support structures and foundations.

Stockpile sign panels and posts removed, on the jobsite at approved locations or as specified, and they shall remain the property of the Department. Remove and dispose of all concrete from sign posts.

When removing signs (panels only), leave the post and footing to accommodate a new or reset sign panel.

Stockpile overhead sign support structures removed, on the jobsite at approved locations or as specified, and they shall remain the property of the Department. Remove sign support structure foundations to a depth of 0.3 m (1 ft) below subgrade or unimproved ground. Where sign support structure foundations conflict with new construction, remove and dispose of the entire foundation.

Backfill resulting holes with approved material and compact as directed.

Exercise care when removing and stockpiling signs and structures that are designated for removal. Repair or replace signs and structures damaged by removal.

**627.03.05 Reset.** Reset existing sign panels on new posts and footings. Existing sign panels will normally be all or portions of those removed according to Subsection 627.03.04.

When resetting sign panels (panels only) and sign panels (overhead), install the panels on existing posts or structures as designated.

Reset existing overhead sign support structures on new foundations.

## METHOD OF MEASUREMENT

**627.04.01 Measurement.** Permanent signs will be measured by the square meter (square foot) of sign face surface.

Permanent signs removed will be measured by the square meter (square foot) of sign panel surface removed.

Permanent signs reset will be measured by the square meter (square foot) of sign panel surface reset.

Permanent sign panels will be measured by the square meter (square foot) of sign panel surface.

Permanent overhead sign support structures will be measured by the lump sum for the support structures.

Permanent overhead sign support structures removed will be measured by the each. Permanent overhead sign support structures reset will be measured by the each.

Roadway embankment material for sign islands will be measured and paid for according to Section 203.

## BASIS OF PAYMENT

**627.05.01 Payment.** The accepted quantities, measured as provided above, will be paid for at the contract price per unit of measurement for the pay items listed below that are shown in the proposal. Payment will be full compensation for the work prescribed in this Section.

Structure excavation and backfill required will be considered subsidiary to the pay items listed below and no further payment will be made therefore.

Payment will be made under:

| Pay Item | Pay Unit |
|---|---|
| Permanent Signs (Ground Mounted) (Metal Supports) | Square Meter (Square Foot) |
| Permanent Signs (Ground Mounted) (Timber Supports) | Square Meter (Square Foot) |
| Permanent Signs, Remove | Square Meter (Square Foot) |
| Permanent Signs, Remove (Panels Only) | Square Meter (Square Foot) |
| Permanent Signs, Reset | Square Meter (Square Foot) |
| Permanent Signs, Reset (Panels Only) | Square Meter (Square Foot) |
| Permanent Sign Panels (Panels Only) | Square Meter (Square Foot) |
| Permanent Sign Panels (Overhead) | Square Meter (Square Foot) |
| Permanent Sign Panels (Overhead) (Remove) | Square Meter (Square Foot) |
| Permanent Sign Panels (Overhead) (Reset) | Square Meter (Square Foot) |
| Permanent Overhead Sign Support Structures | Lump Sum |
| Permanent Overhead Sign Support Structures, Remove | Each |
| Permanent Overhead Sign Support Structures, Reset | Each |

# SECTION 628

## MOBILIZATION

DESCRIPTION

**628.01.01 General.** This work consists of preparatory work and operations necessary for the movement of personnel, equipment, supplies, and incidentals to the project site before beginning work.

This work also consists of furnishing potable water and electricity to Department furnished field laboratories used on the project. Supply the amount of water and electricity necessary to satisfy the requirements of the Department on a 24 hour basis. Make all necessary connections to the laboratories. Qualified personnel who currently hold a Nevada State Contractors Board C2 License Classification shall make electrical connections.

Provide a suitable location for the field laboratories, in a secured area, and on level pads. Satisfactorily construct, maintain, and cleanup a settling pond or holding tank for the laboratory drain.

METHOD OF MEASUREMENT

**628.04.01 Measurement.** Mobilization will be measured by the lump sum.

BASIS OF PAYMENT

**628.05.01 Payment.** The accepted quantity, measured as provided above, will be paid at the contract price per unit of measurement for the pay item listed below that is shown in the proposal. Payment will be full compensation for the work prescribed in this Section.

When mobilization does not appear as an item in the proposal, the cost of such work shall be considered included in the contract unit price bid for other items of work and no additional compensation shall be allowed therefore.

Payment will be made under:

| Pay Item | Pay Unit |
|---|---|
| Mobilization | Lump Sum |

# SECTION 629

## TIME RELATED OVERHEAD

### DESCRIPTION

**629.01.01 General.** This work consists of time related overhead incurred by the Contractor and by any joint venture partner, subcontractor, supplier, or other party associated with the Contractor.

Time related overhead costs include field and home office overhead that are in proportion to the time required to complete the work. Time related overhead does not include costs that are not related to time, including but not limited to; mobilization, licenses, permits, and any other charges incurred only once during the contract.

### CONSTRUCTION

**629.03.01 General.** Field office overhead expenses include time related costs associated with the normal and recurring operations of the construction project, and shall not include costs directly attributable to any of the work of the contract. Such time related costs include, but are not limited to; the salaries and benefits of project managers, general superintendents, field office managers and other field office staff assigned to the project, and rent, utilities, maintenance, security, supplies and equipment costs of the project field office.

Home office overhead or general and administrative expenses refer to the fixed costs of operating the Contractor's business. Such costs include, but are not limited to, general administration, insurance, personnel and subcontract administration, purchasing, accounting, and project engineering and estimating. Home office overhead shall exclude expenses specifically related to other contracts or other businesses of the Contractor, equipment coordination, material deliveries, and consultant and legal fees.

### METHOD OF MEASUREMENT

**629.04.01 Measurement.** Time related overhead will be measured by the day for each eligible working day assessed to the contract, however, not to exceed the number of working days specified in Subsection 108.02, plus or minus authorized changes.

Time related overhead will not be measured for payment during suspensions of work ordered in conformance with the provisions in Subsection 108.04 or 108.06, or any suspensions mutually agreed upon between the Engineer and the Contractor.

In the event of early completion of the contract, the number of days measured for payment will be the number of working days specified in Subsection 108.02, plus or minus authorized changes.

In the event a Value Engineering Proposal is submitted, and is subsequently approved, which provides for a reduction in the number of contract working days, the net savings in the cost of time related overhead due to the decreased working days will be eligible for the provisions of Subsection 105.19.

The provisions in Subsection 104.02 shall not apply to time related overhead.

### BASIS OF PAYMENT

**629.05.01 Payment.** The accepted quantity, measured as provided above, will be paid for at the contract price per unit of measurement for the pay item listed below that is shown in the proposal. Payment will be full compensation for the work prescribed in this Section.

The dollar amount paid per eligible working day will be the contract bid price or 20% of the original contract amount divided by the number of working days specified in Subsection 108.02, whichever is less. Upon completion of all work on the project, payment for any amount due the Contractor will be made.

Payment will be made under:

| Pay Item | Pay Unit |
|---|---|
| Time Related Overhead | Day |

If the quantity of time related overhead, measured as provided above, exceeds 125% of the original contract quantity and the Department provides a written request, submit an audit examination and report of actual overhead

costs within 60 days of such request. Have said audit examination and report performed by an independent Certified Public Accountant in conformance with the requirements of the American Institute of Certified Public Accountants Attestation Standards. The audit examination and report shall depict project and company-wide financial records and shall specify the actual overall average daily rates for both field and home office overhead for the entire duration of the project, and whether the costs have been properly allocated. Do not include unallowable costs, as determined in the Federal Acquisition Regulations, 48 CFR, Chapter 1, Part 31, as part of the field and home office overhead rates. The examination shall determine if the rates of field and home office overhead adhere to the following:

1. Are allowable in conformance with the requirements of the Federal Acquisition Regulations, 48 CFR, Chapter 1, Part 31;
2. Are adequately supported by reliable documentation; and
3. Are related solely to the project under examination.

Upon written request, make financial records available for audit by the State for the purpose of verifying the actual rate of time related overhead established in the submitted audit examination and report. The actual rate of time related overhead established in the submitted audit examination and report will be subject to approval. Payment for time related overhead in excess of 125% of the original contract quantity will be made at the approved rate.

When requested by the Department, the cost of performing an audit examination and submitting the report shall be borne equally by the Contractor and the Department on a 50-50 basis. Such cost will be determined according to Subsection 109.03.

# SECTION 632

## PERMANENT PAINTED PAVEMENT MARKINGS

### DESCRIPTION

**632.01.01 General.** This work consists of applying permanent pavement markings on the completed pavement.

### MATERIALS

**632.02.01 General.** Material shall conform to the following Sections:

Traffic Paint ..... Section 729
Traffic Beads ..... Section 730

Use epoxy, waterborne, or polyurea traffic paint materials as specified for the pavement striping items shown in the proposal.

### CONSTRUCTION

**632.03.01 General.** Perform stakeout for the location of the pavement striping according to the plans, Special Provisions, these specifications, and as directed. The location of striping shall closely parallel the striping pattern depicted on the plan sheets.

Place markings in proper alignment. Do not deviate from alignment by more than 25 mm (1 in.) per 60 m (200 ft) of roadway. Do not exceed 50 mm (2 in.) maximum deviation and do not create abrupt deviations. Remove and replace markings not placed in proper alignment or pattern by approved methods.

Place striping in the direction of traffic flow. Protect the pavement striping from public traffic until dry by the use of traffic cones or by any other approved means.

Painted pavement striping shall be 100 mm (4 in.) wide unless otherwise noted.

The paint pattern for a broken line shall consist of a 3.05 m (10 ft) stripe and a 9.14 m (30 ft) gap.

The paint pattern for a dotted line at lane drops shall consist of a 0.91 m (3 ft) stripe and a 3.66 m (12 ft) gap. The paint pattern for dotted lines (cat tracks) at intersection turn lane lines and at the end of bike lanes at intersections shall consist of a 0.61 m (2 ft) stripe and a 1.22 m (4 ft) gap.

Place permanent striping materials (or temporary markings if allowed) at the end of each day's paving operations or before allowing public traffic on any final plantmix bituminous surface course.

Protect paint lines, symbols, and legends from tracking during the setting period by closing off the wet markings from traffic, using a convoy of moving vehicles to prevent traffic crossing the markings, or saturation of the markings with glass beads to prevent tracking.

**632.03.02 Striping Equipment.** Use only equipment designed for epoxy, waterborne, or polyurea traffic paints. Use equipment with a system capable of spraying both yellow and white paint, mounted on a truck of sufficient size and stability, and having an adequate power source to produce lines of uniform dimension and prevent application failure. Use equipment capable of placing stripes on the left and right sides and of placing two lines simultaneously with either line in a solid or intermittent pattern in yellow or white, and of applying glass beads at the proper rate. Guns shall be in full view of operators at all times. Provide equipment with a metering device to register the accumulated installed footage for each gun, each day. Include at least one operator in each vehicle who is a technical expert in equipment operations and application techniques. Use equipment designed so that the pressure gauges for each pump are constantly visible to the operator at all times during its operation so that any fluctuation and pressure difference can be monitored immediately. Equip each paint tank with a mechanical agitator.

Application equipment for epoxy paint shall have a static mixer unit for proper mixing of the two components of the epoxy paint material.

Application equipment for polyurea paint shall have a static mixer unit for proper mixing of the two components of the polyurea paint material or shall include the impingement mix, airless spray application system for liquid

materials. Pumps shall accommodate a plural component material system that has a volumetric mixing ratio. Equip each resin tank with a mechanical agitator. Select the spray tip, mix chamber, and rod diameter to provide proper mixing. Applicator shall maintain individual resin components and manufacturer's recommended temperature for spray application. Use separate temperature controls for each component.

Application equipment shall have an air nozzle mounted ahead of the spray system to provide high-pressure air cleaning of the pavement surface prior to the application of the polyurea material.

At all times during striping operations, provide free access to application equipment for inspection.

**632.03.03 Surface Preparation.** Remove loose particles, dirt, tar, grease, and other deleterious material from the surface to be marked. Remove existing traffic markings by blasting or grinding. Remove curing compound on Portland cement concrete by blasting. Remove existing markings so that at least 95% of the underlying pavement is visible. Remove the abrasive material from the pavement surface before the pavement is opened to uncontrolled traffic flow.

Any temporary paint applied to delineate traffic lines on new plantmix bituminous open-graded surface, which matches the location and type of the permanent paint, need not be removed before the final application of the pavement striping.

**632.03.04 Application.** (a) Epoxy Pavement Striping. Apply the epoxy paint markings to a clean and dry surface to obtain the following minimum dry thicknesses, measured without drop-on glass beads:

| | |
|---|---|
| On bituminous surface | 500 µm (20 mils) |
| On Portland cement surface | 500 µm (20 mils) |

Dry film thickness will be determined according to Test Method No. Nev. T510.

Apply the epoxy striping on the new plantmix bituminous open-graded surface not sooner than 7 days, nor more than 21 days after completion of the open-graded surface. If the epoxy striping is not applied within the 21 days after completion of the open-graded surface, liquidated damages will be assessed according to Subsection 108.09. The 7 to 21 day application period, and associated liquidated damages, will be applied to specific phasing, staging, or work zones if designated in Subsections 108.04 and 108.09.

Place either temporary markers or temporary epoxy paint to delineate traffic lines on any new plantmix bituminous open-graded surface which does not yet have the permanent striping applied, if required to allow public traffic thereon. If electing to use temporary markers, see Subsection 633.03.03 for installation requirements. If electing to use temporary striping, see Subsection 636.03.01 for application requirements.

Produce markings of uniform thickness and with uniform distribution of glass beads throughout the line width. The width of lines shall be as specified with tolerance of ± 6 mm (1/4 in.) for 100 mm (4 in.) lines and 13 mm (1/2 in.) for wider lines. Produce markings with sharp edges and cutoff at the ends.

The pavement surface where the epoxy is to be placed shall have a minimum temperature of 16 °C (60 °F). The air temperature shall be at least 10 °C (50 °F) during marking operations. Determine the pavement surface temperature and air temperature before the start of each day of marking operations and at any other time ordered.

Heat the epoxy paint marking material to the manufacturer's recommended temperature before application to the pavement.

Apply the traffic beads by the double drop method. This method requires Type I and Type II reflective glass spheres to be injected into or dropped onto the liquid epoxy marking. Apply each type simultaneously, at a minimum rate of 1.1 kg/L (9 lb/gal) of resin to achieve 2.2 kg/L (18 lb/gal) minimum total application. Apply Type I beads first, then immediately follow by the application of Type II beads. The beads shall adhere to the cured epoxy or all marking operations shall cease until corrections are made.

Application rates will be checked at convenient intervals by comparing tallies of materials used to the lengths of lines placed. For initial application, and occasionally during the course of the work, the Engineer may also check application to a preweighed sheet specifically placed for test purposes. Do not apply drop-on spheres for this test.

(b) Rapid Dry Waterborne Traffic Paint. Apply paint to an approved clean and dry surface. Apply by a single application with a machine capable of dispensing beads immediately after paint is applied. Do not use a thinner unless otherwise approved.

Apply the waterborne striping on the new plantmix bituminous open-graded surface not sooner than 7 days, nor more than 21 days after completion of the open-graded surface. If the waterborne striping is not applied within the 21 days after completion of the open-graded surface, liquidated damages will be assessed according to Subsection 108.09. The 7 to 21 day application period, and associated liquidated damages, will be applied to specific phasing, staging, or work zones if designated in Subsections 108.04 and 108.09.

Place either temporary markers or temporary waterborne paint to delineate traffic lines on any new plantmix bituminous open-graded surface which does not yet have the permanent striping applied, if required to allow public traffic thereon. If electing to use temporary markers, see Subsection 633.03.03 for installation requirements. If electing to use temporary striping, see Subsection 636.03.01 for application requirements.

Do not apply paint when the ambient air temperature or the pavement temperature is below 7 °C (45 °F).

Apply Type I waterborne paint markings to obtain a 450 µm (18 mils) minimum wet film thickness and a 270 µm (11 mils) minimum dry film thickness, measured without drop-on glass beads.

Apply Type II waterborne paint markings to obtain a 620 µm (25 mils) minimum wet film thickness and a 380 µm (15 mils) minimum dry film thickness, measured without drop-on glass beads.

Dry film thickness will be determined according to Test Method No. Nev. T510.

Apply beads at a rate of 1.1 kg/L (9 lb/gal) of paint.

Produce markings of uniform thickness and with uniform distribution of glass beads throughout the line width. The width of lines shall be as specified with tolerance of ± 6 mm (1/4 in.) for 100 mm (4 in.) lines and 13 mm (1/2 in.) for wider lines. Produce markings with sharp edges and cutoff at the ends.

Application rates will be checked at convenient intervals by comparing tallies of materials used to the lengths of lines placed. For initial application, and occasionally during the course of the work, the Engineer may also check application to a preweighed sheet specifically placed for test purposes. Do not apply drop-on spheres for this test.

(c) Polyurea Pavement Striping. Apply the polyurea paint markings to a clean and dry surface to obtain the following minimum dry film thicknesses, measured without drop-on glass beads or reflective elements:

| | |
|---|---|
| On bituminous surface | 630 µm (25 mils) |
| On Portland cement surface | 500 µm (20 mils) |

Apply the polyurea striping on the new plantmix bituminous open-graded surface or seal coated surfaces no sooner than 14 days after placement of the open-graded surface or seal coat, but within 28 days. If the polyurea striping is not placed within the 28 days after allowing public traffic thereon, liquidated damages will be assessed according to Subsection 108.09. The 14 to 28 day application period, and associated liquidated damages, will be applied to specific phasing, staging, or work zones if designated in Subsections 108.04 and 108.09.

Place either temporary markers or temporary polyurea paint to delineate traffic lines on any new plantmix bituminous open-graded surface that does not yet have the permanent striping applied, if required to allow public traffic thereon. If electing to use temporary markers see Subsection 633.03.03 for installation requirements. If electing to use temporary striping, see Subsection 636.03.01 for application requirements.

Follow manufacturer’s recommendation for volumetric mixing ratio.

Produce markings of uniform thickness and with uniform distribution of glass beads or glass beads and reflective elements throughout the line width. The width of lines shall be as specified with tolerance of ± 6 mm (1/4 in.) for 100 mm (4 in.) lines and 13 mm (1/2 in.) for wider lines. Produce markings with sharp edges and cutoff at the ends.

The pavement surface where the polyurea is to be placed shall have a minimum temperature of 4 °C (40 °F). The air temperature shall be at least 4 °C (40 °F) during marking operations. Determine the pavement surface temperature and air temperature before the start of each day of marking operations and at any other time as directed.

Heat the polyurea paint marking material to the manufacturer's recommended temperature before application to the pavement.

Apply the reflective media by one of the following methods:

1. Double Drop with Glass Sphere Method. This method requires Type I and Type II reflective glass spheres to be injected into or dropped onto the liquid polyurea marking. Apply each type simultaneously, at a minimum rate of 1.1 kg/L (9 lb/gal) of resin to achieve 2.2 kg/L (18 lb/gal) minimum total application. Apply Type I beads first, then immediately follow by the application of Type II beads. The beads shall adhere to the cured polyurea or all marking operations shall cease until corrections are made.

2. Double Drop with Glass Sphere and Reflective Element Method. This method requires Type III glass spheres and reflective elements to be dropped onto the liquid polyurea marking. Apply reflective media simultaneously, at a minimum rate of 1.0 kg/L (8.0 lb/gal) of glass spheres and a minimum rate of 0.64 kg/L (5.4 lb/gal) of reflective elements for a 500 µm (20 mil) binder thickness application. Minimum application rates shall be 0.75 kg/L (6.36 lb/gal) of glass spheres and 0.5 kg/L (4.24 lb/gal) of reflective elements for a 630 µm (25 mil) binder thickness application. Apply the reflective elements first, then immediately follow by the application of the glass spheres. The reflective media shall adhere to the cured polyurea or all marking operations shall cease until corrections are made.

Conduct one or more test strips prior to the start of striping operations. If an adequate location does not exist on the project site for applying the test strips, supply roofing paper and place on the pavement to construct the test strips. Each test strip shall consist of approximately 30 m (100 ft) of linear pavement striping similar to that required for the project. The purpose of the test strips is to demonstrate the capability of the proposed polyurea resin striping material, the equipment, and procedures to place polyurea resin traffic stripes that comply with these specifications including dimensions, appearance (uniform color and crisp, well defined edges), wet film thickness, drying time, application, and retention. When the test strips are in compliance, striping operations will be permitted to proceed.

**632.03.05 Final Acceptance.** Final acceptance will be based on compliance with these specifications.

Provide a 30 m geometry reflectometer from one of the manufacturers listed in the QPL for reflectivity measurements. Take retroreflective readings one to two weeks after installation of pavement striping. Perform retroreflective readings according to Test Method No. Nev. T511. The locations and number of readings for the type of pavement striping will be determined. The completed marking shall conform to the following requirements:

| Type | Color | Specific Luminance, mcd/($m^2$ • lux) |
|---|---|---|
| Epoxy | White | 375 Minimum |
| Epoxy | Yellow | 275 Minimum |
| Waterborne | White | 250 Minimum |
| Waterborne | Yellow | 175 Minimum |
| Polyurea | White | 550 Minimum |
| Polyurea | Yellow | 300 Minimum |

## METHOD OF MEASUREMENT

**632.04.01 Measurement.** Epoxy, waterborne, and polyurea pavement striping will be measured by the linear meter (linear foot), kilometer (mile), or square meter (square foot) for the type specified.

Double solid and broken w/solid lines will be considered as a single line when measured for payment. Gaps in broken and dotted lines will be included in the linear measurement.

## BASIS OF PAYMENT

**632.05.01 Payment.** The accepted quantities, measured as specified above, will be paid for at the contract price per unit of measurement for the pay items listed below that are shown in the proposal. Payment will be full compensation for the work prescribed in this Section.

Payment will be made under:

| Pay Item | Pay Unit |
|---|---|
| Epoxy Pavement Striping (*) | Linear Meter or Kilometer (Linear Foot or Mile) |
| Epoxy Pavement Striping (Varies) | Square Meter (Square Foot) |
| Waterborne Pavement Striping (type) (*) | Linear Meter or Kilometer (Linear Foot or Mile) |
| Waterborne Pavement Striping (type) (Varies) | Square Meter (Square Foot) |
| Polyurea Pavement Striping (*) | Linear Meter or Kilometer (Linear Foot or Mile) |
| Polyurea Pavement Striping (Varies) | Square Meter (Square Foot) |

* Color and pattern as indicated in the proposal.

# SECTION 633

## PAVEMENT MARKERS

### DESCRIPTION

**633.01.01 General.** This work consists of furnishing and placing pavement markers.

Use pavement markers of an approved color. Off-color markers shall constitute grounds for rejection.

This work also consists of furnishing and placing temporary reflective lane line markers.

### MATERIALS

**633.02.01 Non-Reflective Pavement Markers.** Non-reflective pavement markers shall consist of a heat-fired, vitreous, ceramic base and a heat-fired, opaque, glazed surface. Produce the markers from any suitable combination of intimately mixed clays, shales, tales, flints, feldspars, or other inorganic material.

Thoroughly and evenly mature and free the markers from defects which effect appearance or serviceability.

The top surface of the non-reflective marker shall be convex and the radius of curvature shall be between 88 mm (3.5 in.) and 150 mm (6 in.), except that the radius of the 12.5 mm (0.5 in.) nearest the edge may be less. Any change in curvature shall be gradual. The top and sides shall be smooth and free of mold marks, pits, indentation, air bubbles, or other objectionable marks or discolorations.

The bottom of the ceramic markers shall be free from gloss or glaze and shall have areas of integrally formed protrusions projecting from the surface which will increase the effective bonding surface area of adhesive. The faces of the protrusions shall not deviate more than 1 mm (0.04 in.) from a flat surface. The areas of protrusion shall have faces parallel to the bottom of the marker and shall project approximately 1 mm (0.04 in.) from the bottom. The area of protrusions shall constitute a minimum of 30% of the area of the bottom of the marker and shall increase the bonding surface area by a minimum of 24%. To facilitate forming and mold release, the sides of the protruded area may be tapered. This taper shall not exceed 15 degrees from the perpendicular to the marker bottom.

The non-reflective ceramic type markers shall conform to the following tests:

(a) Adhesive Bond Strength (to bottom surface of the marker) ..... 4.8 MPa (700 psi) Min.
(b) Glaze Thickness ..... 130 µm (5 mil) Min.
(c) Moh Hardness ..... 6 Min.
(d) Directional Reflectance (white markers only)
  1. Glazed Surface ..... 7 Min.
  2. Body of Marker ..... 65 Min.
(e) Yellowness Index (white markers only)
  1. Glazed Surface ..... 7 Max.
  2. Body of Marker ..... 16 Max.
(f) Color (yellow markers only)
  1. Purity ..... 76% to 96%
  2. Dominant Wave Length ..... 579 to 585 nm
  3. Total Luminous Reflectance (Y value x 100) ..... 41 Min.
(g) Autoclave Reflectance ..... Glaze shall not spall, crack, or peel
(h) Strength ..... 6,670 N (1,500 lb) Min.
(i) Water Absorption ..... 2.0% Max.

Plastic non-reflective pavement markers may be used in lieu of the ceramic type markers specified above. The plastic type markers shall be either polyester or acrylonitrile butadiene styrene (ABS) plastic type.

Polyester markers shall consist of polyester resin binder, inert organic filler material, and colorant pigments and shall conform to the test requirements for ceramic type markers except the requirement for adhesive bond strength in Test (a) shall be 3.3 MPa (480 psi) minimum and Tests (b), (c), (g), and (i) shall not apply.

ABS markers shall consist of ABS plastic conforming to ASTM D4673, Designation ABS0122, and shall conform to the test requirements for ceramic type markers except Tests (a), (b), (c), (g), and (i) shall not apply. The bottom of ABS plastic markers shall be configured to produce a structural bond with the pavement.

Use non-reflective pavement markers listed in the QPL.

**633.02.02 Reflective Pavement Markers.** Reflective pavement markers shall be of the prismatic reflector type consisting of a methyl methacrylate or suitably compounded acrylonitrile butadiene styrene (ABS) shell filled with a mixture of an inert thermosetting compound and filler material. The exterior surface of the shell shall be smooth and contain one or two methyl methacrylate prismatic reflector faces of the color specified.

The reflective lens shall not contain any voids of airspace and the back lens shall be metallized. Fabricate the shell with a mechanical interlock between the thermosetting compound and the shell. Bond the thermosetting compound directly to the backside of the metallized lens surface.

The base of the marker shall be flat [the deviation from a flat surface shall not exceed 1 mm (0.04 in.)], rough textured and free from gloss or substances which may reduce its bond to the adhesive.

The color of the reflector when illuminated by an automobile headlight shall be an approved color. Off-color reflection shall constitute grounds for rejection. The daylight color of the marker body shall be an approved color, compatible with the color of the primary lens.

Note that the 100 mm (4 in.) x 100 mm (4 in.) x 10 mm (0.4 in.) size of the reflective pavement marker shown on Standard Plan Sheet T-37.1.1 is only a common size and other sizes of markers may be accepted.

The reflective type markers shall conform to the following tests:

(a) Adhesive Bond Strength (to bottom surface of the markers) ..... 3.4 MPa (500 psi) Min.
(b) Reflectance ..... Specific Intensity

| | Clear | Yellow | Red |
|---|---|---|---|
| 0 degree Incidence Angle, Min. | 3.0 | 1.5 | 0.75 |
| 20 degrees Incidence Angle, Min. | 1.2 | 0.60 | 0.30 |

(c) Strength ..... 8,900 N (2,000 lb) Min.
(d) Water Soak Resistance ..... No delamination of body or lens system of marker nor loss of reflectance

Failure of the markers body or filler material before reaching 3.4 MPa (500 psi) in the bond strength test, test (a) above, shall also constitute a failing bond strength test.

Deformation of the marker of more than 3 mm (0.125 in.) at a load of less than 8,900 N (2,000 lb) or delamination of the shell and the filler material of more than 3 mm (0.125 in.) regardless of the load required to break the marker shall be cause for rejection of the marker.

Use reflective pavement markers listed in the QPL.

**633.02.03 Recessed Reflective Pavement Markers.** Reflective pavement markers to be placed in pavement recesses shall conform to Subsection 633.02.02 with the following exceptions. The pavement markers need not conform to the strength requirements, and the specific intensity requirements shall apply after abrading the lens surface by the following Steel Wool Abrasion Procedure:

> Form a 25 mm (1 in.) diameter flat pad using No. 3 coarse steel wool conforming to FSS FF-W-1825. Place the steel wool pad on the reflector lens. Apply a load of 23 kg (50 lb) and rub the entire lens surface 100 times.

Use recessed reflective pavement markers listed in the QPL.

**633.02.04 Adhesive for Pavement Markers.** Use adhesives for pavement markers listed in the QPL.

**633.02.05 Temporary Reflective Lane Line Markers.** Use temporary reflective lane line markers listed in the QPL.

The temporary lane line markers used for centerlines shall have yellow bodies and yellow reflective sheeting on both sides.

The temporary lane line markers used for lane lines or edge lines shall have the same body and reflector color as required for the permanent striping and the reflective sheeting shall be only required on the side that faces oncoming traffic.

**633.02.06 Certificates.** Furnish certificates of compliance executed by the manufacturers of the markers and adhesives attesting that they conform to these specifications.

CONSTRUCTION

**633.03.01 Pavement Marker Installation.** Remove dirt, curing compound, grease, oil, moisture, loose or unsound layers, paint and any other deleterious material from the surface to be marked. Clean Portland cement concrete by blast cleaning. Uniformly place the adhesive on the cleaned pavement surface or on the bottom of the marker in a quantity sufficient to result in complete coverage of the area of the contact of the marker with no voids present and with a slight excess after the marker has been pressed in place. Place the marker in position and apply pressure until firm contact is made with the pavement. Immediately remove excess adhesive around the edge of the marker, on the pavement, and on the exposed surfaces of the markers. Remove adhesive from exposed faces of pavement markers with soft rags moistened with mineral spirits or kerosene.

Prepare and apply the adhesive according to the manufacturer's requirements. Protect the markers against impact until the adhesive has sufficiently hardened to keep traffic from dislodging the markers.

Install markers to the line established by the Engineer. Install reflective markers so that the reflective face of the marker is at right angles to a line parallel to the roadway centerline.

Do not install pavement markers over longitudinal or transverse joints of the pavement surface.

**633.03.02 Pavement Recesses.** Locate pavement recesses along the line of new or existing stripes. Select method to construct recesses. Use power-operated equipment capable of removing the pavement to the dimensions shown on the plans. Remove residue from the roadbed with vacuum equipment and dispose according to Subsection 107.14.

**633.03.03 Temporary Lane Line Marker Installation.** Install temporary lane line markers according to the manufacturer's recommendations. Maintain the markers by replacing lost or damaged markers daily.

Use temporary lane line markers specified in Subsection 633.02.05.

The patterns and spacing for the temporary pavement markers shall be as follows:

1. For broken lines, place groups of 3 markers spaced longitudinally 600 mm (24 in.) apart at 12 m (40 ft) intervals.
2. For double yellow lines, place 2 markers side by side with a 100 mm (4 in.) separation between markers at 6 m (20 ft) intervals.
3. For the centerline in a one way passing zones, place 2 markers side by side with a 100 mm (4 in.) separation between markers at 6 m (20 ft) intervals.
4. For edge lines, place markers at 6 m (20 ft) intervals.

(a) Installation of Temporary Markers on Open-Graded Surface. Temporary markers may be required to be placed on the new plantmix bituminous open-graded surface. See Subsection 632.03.04 for limitations on the application of pavement striping and optional placement of temporary markers.

The adhesive used with the temporary lane line markers shall not damage the pavement surface when they are removed. Remove the markers placed on the new plantmix bituminous open-graded surface just before the application of the permanent striping.

There will be no additional compensation for furnishing, installing, maintaining, and removing temporary lane line markers placed on the new plantmix bituminous open-graded surface before applying the permanent striping.

(b) Installation of Temporary Markers with the Application of Screenings. In areas to receive a surface treatment of screenings, apply the temporary lane line markers before application of the bituminous material. After placement of screenings and before allowing public traffic on the roadway surface, remove the clear protective coverings from the temporary lane line marker reflectors.

Equip temporary lane line markers with an additional clear protective covering when a seal coat is to be applied on the screenings. After application of the seal coat and before allowing public traffic on the roadway surface, remove the secondary clear protective coverings from the temporary lane line marker reflectors.

Maintain the markers by replacing lost or damaged markers daily. The markers need not be removed after the application of the permanent striping.

METHOD OF MEASUREMENT

**633.04.01 Measurement.** Pavement markers or temporary lane line markers will be measured by the each.

BASIS OF PAYMENT

**633.05.01 Payment.** The accepted quantities, measured as provided above, will be paid for at the contract price per unit of measurement for the pay items listed below that are shown in the proposal. Payment will be full compensation for the work prescribed in this Section.

Payment will be made under:

| Pay Item | Pay Unit |
|---|---|
| Non-Reflective Pavement Markers | Each |
| Reflective Pavement Markers | Each |
| Reflective Pavement Markers (Recessed) | Each |
| Temporary Lane Line Markers (color) | Each |

# SECTION 634

## PAVEMENT MARKING FILM

### DESCRIPTION

**634.01.01 General.** This work consists of furnishing and placing pavement marking tape and thermoplastic marking material.

### MATERIALS

**634.02.01 General.** Material shall conform to the following Section:

Pavement Marking Film ..... Section 732

Protect marking film from unnecessary exposure to extreme temperatures before installation by proper packaging and storage. Marking film showing signs of physical damage or effects of prolonged storage which may affect its performance will be rejected.

**634.02.02 Thermoplastic Material.** Use either hot applied or preformed thermoplastic materials for the thermoplastic pavement marking items shown in the proposal. The thermoplastic pavement marking materials shall be capable of application on asphaltic surfaces and Portland cement concrete surfaces.

### CONSTRUCTION

**634.03.01 General.** Perform stakeout for the proper location of the pavement marking film.

The pavement marking film shall be 100 mm (4 in.) wide unless noted otherwise.

The pattern for a broken line shall consist of a 3 m (10 ft) stripe and a 9 m (30 ft) gap.

Provide marking film colors and configurations according to the plans and the MUTCD.

Apply the pavement marking film to new open-graded plantmix surface before public traffic is allowed on the freshly paved surface.

**634.03.02 Pavement Marking Tape.** Inlay tape in the fresh surface during the final rolling of the mat before the open-graded plantmix surface temperature falls below 71 °C (160 °F).

Apply pavement marking tape as per manufacturer's recommendations.

Within 48 hours after application, the tape shall resist a minimum 35 N (8 lb) pull when tested according to Test Method No. Nev. T512.

**634.03.03 Thermoplastic Material Application.** Produce thermoplastic markings that are straight and have sharp edges: that are the specified color, width, and thickness; that have uniform retroreflectivity; and that are properly bonded to the pavement.

(a) Hot Applied Thermoplastic. Mechanically wire brush the existing surface which is to receive the thermoplastic material to remove all dirt and contaminants. Mechanically wire brush or abrasive blast clean the surface of new Portland cement concrete which is to receive the thermoplastic material to remove all laitance and curing compound.

Remove and replace any existing pavement markings damaged by the blast cleaning or wire brushing.

Apply the thermoplastic material to dry pavement surfaces and only when the surface temperature is above 10 °C (50 °F).

Apply a primer, of the type recommended by the manufacturer of the thermoplastic material, to all asphaltic surfaces over 6 months old and to all Portland cement concrete surfaces. Apply the primer immediately in advance of, but concurrent with, the application of the thermoplastic material. Apply the primer at the application rate recommended by the manufacturer and do not thin.

Use preheaters with mixers having 360 degree rotation to preheat material.

Apply the thermoplastic material to the pavement at a temperature between 200 °C and 220 °C (400 °F and 425 °F), unless a different temperature is recommended by the manufacturer.

The thermoplastic material may be applied by either spray or extruded methods in a single uniform layer.

Use stencils when applying thermoplastic material for pavement markings.

Uniformly coat the pavement surface and fill the voids in the pavement surface with the thermoplastic material.

Apply the thermoplastic material to dry pavement at a thickness of 2.5 to 3.8 mm (0.100 to 0.150 in.) for pavement markings and a minimum thickness of 1.5 mm (0.060 in.) for traffic stripes.

Apply traffic beads immediately to the surface of the molten thermoplastic material at a rate of not less than 4 kg per 10 $m^2$ (8 lb per 100 $ft^2$).

(b) Preformed Thermoplastic. Place the preformed thermoplastic material on clean and thoroughly dry surfaces and during anticipated dry weather. Mechanically wire brush or abrasive blast clean the surface of new Portland cement concrete which is to receive the thermoplastic material to remove all laitance and curing compound.

The pavement temperature and ambient air temperature shall be at or above 0 °C (32 °F) at the time of application.

Melt the properly positioned preformed thermoplastic using flame from a propane-type torch, according to the manufacturer's recommendations, to bond the traffic markings permanently in place.

If recommended by the manufacturer of the preformed thermoplastic pavement markings, apply a primer sealer on Portland cement concrete surfaces before application of the preformed thermoplastic material.

Manufacturers of preformed thermoplastic pavement marking material are listed in the QPL.

## METHOD OF MEASUREMENT

**634.04.01 Measurement.** Pavement marking tape and thermoplastic pavement marking will be measured by the linear meter (linear foot), kilometer (mile) or square meter (square foot).

Double solid and broken w/solid lines will be considered as a single line when measured for payment. Gaps in broken and dotted lines will be included in the linear measurement.

## BASIS OF PAYMENT

**634.05.01 Payment.** The accepted quantities, measured as provided above, will be paid for at the contract price per unit of measurement for the pay items listed below that are shown in the proposal. Payment will be full compensation for the work prescribed in this Section.

Payment will be made under:

| Pay Item | Pay Unit |
|---|---|
| Pavement Marking Tape (type) (Varies) | Square Meter (Square Foot) |
| Pavement Marking Tape (type) (*) | Linear Meter (Linear Foot) |
| Pavement Marking Tape (type) (*) | Kilometer (Mile) |
| Thermoplastic Pavement Marking (Varies) | Square Meter (Square Foot) |
| Thermoplastic Pavement Marking (*) | Linear Meter (Linear Foot) |
| Thermoplastic Pavement Marking (*) | Kilometer (Mile) |

* Width, pattern, or color as indicated in the proposal.

# SECTION 635

## TEMPORARY PAVEMENT STRIPING TAPE

### DESCRIPTION

**635.01.01 General.** This work consists of furnishing, locating, placing, maintaining, and removing temporary pavement striping tape.

### MATERIALS

**635.02.01 General.** The use of Type 1 tape is mandatory, unless Type 2 tape is approved for use on areas appropriate for its use. Temporary striping tape shall be yellow or white as required.

Type 1 tape shall conform to ASTM D4592, Type I. Type 1 tape is more readily removable from the surface and is recommended for use on surfaces which are not designated to be covered or removed, and on temporary areas where traffic patterns are to be altered.

Type 2 tape shall conform to ASTM D4592, Type II. Type 2 tape is much more difficult to remove from the surface and is recommended for use on surfaces which are to be covered or removed in which case removal of the tape will not usually be required.

Use temporary striping tape listed in the QPL.

### CONSTRUCTION

**635.03.01 General.** Temporary striping tape used on interstate and full control of access freeways shall be 100 mm (4 in.) wide for edge and lane lines, 200 mm (8 in.) wide for ramp gore lines, and 300 mm (12 in.) wide for stop bars and cross walks. Temporary striping tape used on other roads shall be 100 mm (4 in.) wide, except stop bars and cross walks shall be 300 mm (12 in.) wide. Place railroad markings according to the Standard Plans.

The tape pattern for a broken line shall consist of a 3 m (10 ft) stripe and a 9 m (30 ft) gap.

Temporary Striping Tape (Pilot Line) shall be 100 mm (4 in.) by 300 mm (12 in.) sections and shall be placed on traffic lane lines at 12 m (40 ft) intervals with the longer side parallel to traffic.

Provide tape color and configurations according to the plans and the MUTCD.

Place temporary striping tape before end of a working day and/or before allowing public traffic on the surface.

Apply to surface which is dry, free of oils, grease, dust, and dirt. Tamp the tape down immediately after application in order to obtain a proper bond. Satisfactorily remove tape when required. Completely remove tape in such a manner that no residue or any other trace of the tape may be misconstrued by a driver to be a traffic marking under any condition of daylight, darkness, or wetness of the pavement.

Portions of the temporary striping tape may have to be replaced during the life of the contract. The locations and extent of these replacements will be determined. No additional compensation will be made for replacing tape.

### METHOD OF MEASUREMENT

**635.04.01 Measurement.** Temporary striping tape will be measured by the linear meter (linear foot), including gaps, or by the square meter (square foot).

### BASIS OF PAYMENT

**635.05.01 Payment.** The accepted quantities, measured as provided above, will be paid for at the contract price per unit of measurement for the pay items listed below that are shown in the proposal. Payment will be full compensation for the work prescribed in this Section.

Payment will be made under:

| Pay Item | Pay Unit |
|---|---|
| Temporary Striping Tape (type) | Linear Meter (Linear Foot) |
| Temporary Striping Tape (Varies) | Square Meter (Square Foot) |

# SECTION 636

## TEMPORARY PAINTED PAVEMENT MARKING

### DESCRIPTION

**636.01.01 General.** This work consists of the application of temporary pavement striping paint and traffic beads.

### MATERIALS

**636.02.01 General.** Material shall conform to the following Sections:

Traffic Paint ..... Section 729
Traffic Beads ..... Section 730

Use epoxy traffic paint materials for temporary painted striping placed on surfaces to receive permanent epoxy striping.

Use waterborne traffic paint materials for temporary painted striping placed on surfaces to receive permanent waterborne striping.

Use polyurea traffic paint materials for temporary painted striping placed on surfaces to receive permanent polyurea striping.

### CONSTRUCTION

**636.03.01 General.** The finished surface of each course of dense-graded plantmix surface shall be painted prior to placing public traffic thereon. The pattern for this painting shall closely parallel the pattern shown in the plans for the permanent striping, the requirements of the Special Provisions, or the pattern shown for traffic control. Properly locate painted traffic lines.

Temporary painted pavement markings placed on interstate and full control of access freeways shall be 100 mm (4 in.) wide for edge and lane lines, 200 mm (8 in.) wide for ramp gore lines, and 300 mm (12 in.) wide for stop bars and cross walks. Temporary painted pavement markings used on other roads shall be 100 mm (4 in.) wide, except stop bars and cross walks shall be 300 mm (12 in.) wide. Place railroad markings according to the Standard Plans.

The paint pattern for a broken line shall consist of a 3 m (10 ft) stripe and a 9 m (30 ft) gap.

Provide paint color and configurations according to the plans and the MUTCD.

If directed to repaint due to normal wear, said work will be measured for payment according to Subsection 636.04.01. Should repainting be required for any purpose other than normal wear as determined by the Engineer, no additional compensation will be allowed for costs.

Apply paint to an approved clean and dry surface. Apply by a single application with a machine capable of dispensing beads immediately after paint is applied. Do not use a thinner unless otherwise approved.

Apply paint when the ambient air temperature is above 7 °C (45 °F). Paint may be applied when the ambient air temperature is below 7 °C (45 °F), but above 0 °C (32 °F), provided the road surface is free of any possible sources of moisture or condensation during application.

Use traffic cones or other approved means to protect the pavement striping from public traffic until dry. Do not heat the paint above 63 °C (145 °F) to reduce drying time.

Except for application on open-graded surfaces, apply paint at a rate to produce a minimum film thickness of 200 µm (8 mils) when dry. Dry film thickness will be determined according to Test Method No. Nev. T510.

Apply glass beads at the rate of 720 g/L (6 lb/gal) of paint. Use Type II beads for epoxy or polyurea.

The application will be checked at the beginning of each day's striping and as often thereafter as considered necessary. If equipment settings fail to produce quality striping within the limits specified, stop striping until the cause is corrected.

Temporary painted striping may be required to be placed on the new plantmix bituminous open-graded surface. See Subsection 632.03.04 for limitations on the application of pavement striping and optional application of temporary painted striping.

The location and pattern for temporary striping applied on the new open-graded surface shall closely parallel the location and pattern shown in the plans for the permanent striping. Temporary striping widths shall be as specified above.

Apply the temporary painted striping on the new open-graded surfaces to obtain a minimum dry film thickness of 150 µm (6 mils), measured without beads. Apply glass beads at the rate of 720 g/L (6 lb/gal) of paint. Use Type II beads for epoxy or polyurea.

There will be no additional compensation for furnishing, applying, and maintaining the temporary painted striping on the new open-graded surfaces before applying the permanent striping.

Provide a 30 m geometry reflectometer from one of the manufacturers listed in Subsection 632.03.05 of the QPL for reflectivity requirements. Perform retroreflective measurements according to Test Method No. Nev. T511. The locations and number of measurements will be determined. Maintain all temporary striping throughout the duration of construction in a condition that meets the following requirements:

| Color | Specific Luminance, mcd/($m^2 \cdot$ lux) |
|---|---|
| White | 175 Minimum |
| Yellow | 125 Minimum |

If the open-graded surface is not completed and unscheduled winter suspension occurs due to Contractor's operations, be responsible for all costs for installation and maintenance of temporary striping. The Engineer will determine if the unscheduled winter suspension was due to the Contractor's operations. Maintain temporary striping during the winter suspension as directed. Comply with directives regarding maintenance of temporary striping within 5 working days.

## METHOD OF MEASUREMENT

**636.04.01 Measurement.** Temporary painted striping will be measured by the linear meter (linear foot), kilometer (mile), or square meter (square foot).

Double solid and broken w/solid lines will be considered as a single line when measured for payment. Gaps in broken or dotted lines will be included in the linear measurement.

## BASIS OF PAYMENT

**636.05.01 Payment.** The accepted quantities, measured as provided above, will be paid for at the contract price per unit of measurement for the pay items listed below that are shown in the proposal. Payment will be full compensation for the work prescribed in this Section.

Payment will be made under:

| Pay Item | Pay Unit |
|---|---|
| Temporary Painted Striping (*) | Linear Meter (Linear Foot), Kilometer (Mile), or Square Meter (Square Foot) |

* Color and type (solid or broken) as indicated in the proposal.

# SECTION 637

## TEMPORARY POLLUTION CONTROL

DESCRIPTION

**637.01.01 General.** This work consists of the installation, maintenance, and removal of temporary pollution control Best Management Practices (BMPs) intended to provide prevention, control, and abatement of water and air pollution during construction of the project to the maximum extent practicable.

Temporary pollution control and erosion control work shall conform to the requirements of NDOT's "Construction Site Best Management Practices (BMPs) Manual," hereinafter referred to as the Manual, and addenda thereto issued up to, and including, the date of advertisement of the contract. The Manual is available for purchase, or can be accessed on the NDOT website. Adhere to the Manual's minimum requirements found in Section 2 for the selection and implementation of construction site BMPs. Know and fully comply with the provisions of the Manual, and Federal, State, and local regulations governing storm and non-storm water discharges from both the project site and areas of disturbance outside the project limits during construction.

Pursuant to NRS Chapter 625, a Nevada Registered Civil Professional Engineer (PE) shall design and/or review and stamp plans that require engineered calculations. BMPs requiring sizing shall be designed and/or reviewed and approved by a qualified Professional Civil Engineer, registered in the State of Nevada. Refer to Section I.B. of the Stormwater General Permit NVR100000 and the Manual fact sheets for determining when designed BMPs are required.

A Storm Water Pollution Prevention Plan (SWPPP) shall be developed and implemented and documented stormwater inspections shall be performed once every 7 days and within 24 hours of storm events 12.5 mm (0.5 in.) or greater, regardless of Stormwater General Permit NVR100000 procurement.

Temporary pollution control BMPs shall remain in-place until contract work requiring their removal occurs or final stabilization as defined in the Stormwater General Permit NVR100000 is achieved.

**637.01.02 Water Pollution Control Manager.** Designate a Water Pollution Control Manager who has successfully completed a minimum of 8 hours of stormwater training within the last 3 years. The training shall include stromwater permitting requirements, implementation and inspection of temporary pollution control BMPs, recognition of construction activities that may impact stormwater quality, and identification of illicit discharges or illicit connections to the storm sewer system. Submit training certificates prior to the start of construction activities.

The Water Pollution Control Manager shall be responsible for the preparation of the Stormwater General Permit NVR100000, Temporary Working in Waterways/Discharge Permit, and/or De Minimis Clean Water Discharge Permit applications and their required modifications or amendments. The Water Pollution Control Manager shall be responsible for developing and implementing the SWPPP as specified by the Stormwater General Permit NVR100000 and these specifications. The Water Pollution Control Manager shall be responsible for installing, maintaining, and removing all temporary pollution control BMPs shown on the SWPPP, in accordance with the requirements of the Stormwater General Permit NVR100000, the Manual, and as directed. The Water Pollution Control Manager shall serve as the primary contact for issues related to the SWPPP, permits or their implementation and shall be available 24 hours a day from the first day of activities until final stabilization is achieved for the entire project, or the contract is completed, whichever occurs first. The Water Pollution Control Manager shall be responsible for reporting to the Engineer any illicit discharges (40 CFR § 122.26(b)(2)) or illicit connections to the storm sewer system found within the project limits no later than 24 hours of discovery.

**637.01.03 Permits.** Not all projects require the permits discussed in this Subsection. See the Manual for criteria mandating permit procurement. Contact the Nevada Division of Environmental Protection (NDEP), Bureau of Water Pollution Control, a minimum of 7 days prior to the preconstruction conference to procure the appropriate permits. Inform NDEP if equipment will operate in drainages or if dewatering is planned to accomplish the items of work.

(a) Stormwater General Permit NVR100000. Prepare a Storm Water Pollution Prevention Plan (SWPPP) prior to submittal of the Notice of Intent (NOI). File an NOI a minimum of 2 working days prior to commencement of construction with NDEP with appropriate filing fee to obtain coverage under the Stormwater General Permit NVR100000. Include the Engineer's name and NDOT contract number in Section 2 of the NOI. Ensure that the billing information (Section 4 of the NOI) reflects that the Operator (Contractor) is to receive the invoice for annual permit renewal. Ensure that NDOT's Contract Number is referenced in the NOI.

Provide a copy of the NOI Certification Statement prior to beginning work.

Furnish a copy of the initial SWPPP prior to the commencement of any construction activities. The SWPPP will not be reviewed or approved by NDOT or NDEP, but is provided as evidence of SWPPP preparation. The SWPPP shall remain on the project site, updated according to NDEP requirements, as a living document during the project and shall be made immediately available upon request to NDEP, NDOT, FHWA, or government officials inspecting the construction site.

Document existing vegetation in areas that will be disturbed with photographs before commencing ground-disturbing activities. Prior to filing the Notice of Termination with NDEP, photo-document the post construction site conditions to demonstrate the vegetation re-establishment or post project stabilization. Submit electronic or digital color photos for pre and post construction stabilization documentation.

Design and install BMPs such that flooding or ponding is not caused outside of right-of-way or poses a hazard to motorists, pedestrians, or any other user.

Refer to Section II.A. of the Stormwater General Permit NVR100000 for complete SWPPP requirements, and to the Manual fact sheets for individual BMP minimum requirements.

Use the SWPPP template found in the Manual or another template acceptable to NDEP. Refer to the NDEP website http://ndep.nv.gov/bwpc/storm01.htm for a copy of the Stormwater General Permit NVR100000 and information pertaining to SWPPP development.

Stormwater General Permit NVR100000 covers storm water discharges from Department-furnished material sources for general fill material, aggregate and/or staging a temporary asphalt or concrete batch plant operation dedicated solely to this contract. Address temporary pollution control BMPs for these areas in the SWPPP.

(b) Temporary Working in Waterways/Discharge Permit. This permit is required whenever construction is performed within, or in the vicinity of, “Waters of the State” (NAC 445A.415) and/or whenever 401 Water Quality Certification is required. Said work is intended to provide prevention and control of pollutants and sediment transport downstream by employing BMPs.

Prior to commencing work below the ordinary high water mark of a “Waters of the State,” submit to the NDEP Bureau of Water Pollution Control, Permits Branch, the required permit application for a Temporary Working in Waterways/Discharge Permit to be issued to the Contractor. The review and approval process may take up to four weeks. If a change is proposed to the information contained in the approved permit application, contact NDEP for their approval. Changes shall not be made in the field until receiving NDEP approval.

(c) Temporary Discharge Permit. If a Temporary Working in Waterways/Discharge Permit is not required for a project including dewatering operations, a Temporary Discharge Permit may be necessary. Review Manual fact sheet NS-2 of Section 6 for specific requirements.

(d) De Minimis General Permit NVG201000. This permit authorizes specific intermittent or continuous discharges into a “Waters of the U.S.” (33 CFR § 328). Refer to the permit for discharge specific NOI sampling requirements, discharge limitations, monitoring requirements, and conditions. Submit a signed copy of the NOI Certification Statement.

**637.01.04 Noxious Weed Management.** Develop and follow a Noxious Weed Management Plan to prevent the establishment and spread of Nevada State listed noxious weeds per NRS 555 (available at http://agri.nv.gov/PLANT_NoxWeeds_index.htm).

The management plan shall include mapping of existing noxious weed populations, appropriate eradication/control methods based on weed type, location, applicator certification, monitoring, and retreatment as necessary. Include methods for keeping equipment, personnel, staging areas, construction and excavation sites, and roadways clear of noxious weed plants and seeds. The plan shall also address the treatment of weeds in topsoil salvage material. Submit the plan at the pre construction meeting.

Equipment leaving noxious weed infested areas shall be cleaned prior to moving to another location. Equipment coming into or leaving the project area shall be cleaned and the cleaning area kept clear of plant material and contaminated dirt to prevent weed spread.

CONSTRUCTION

**637.03.01 General.** On any project requiring 401 Water Quality Certification, submit digital or electronic color photographs with associated description of sediment and erosion structural controls and BMPs within two weeks of their installation.

Be responsible throughout the duration of the project for installing, constructing, inspecting, maintaining, replacing, removing, and disposing of the BMPs specified in the SWPPP, Temporary Working in Waterways Permits, and any other applicable permit. Install BMPs at the earliest practicable time for each construction phase.

Repairs and/or placement of temporary pollution control BMPs shall begin within 24 hours of notification of a deficiency and shall be completed within 7 days. Should this restriction be exceeded, work may be immediately suspended and no other items of work shall be performed until the repairs are completed. Working days will continue to be assessed during the suspension period and partial payments as set forth under Subsection 109.06 may not be forthcoming until said repairs are completed.

Do not remove BMPs until the disturbed area being protected achieves final stabilization as defined by Stormwater General Permit NVR100000. This may require BMPs be left in-place following the completion of construction activities. Properly maintain such BMPs, specified in the Manual, until the project is accepted.

Submit a copy of the most updated SWPPP upon contract completion.

File a separate NOI with NDEP to apply for coverage under the Stormwater General Permit NVR100000 for ground disturbance areas outside of NDOT Right-of-Way and not displayed in the plans. Contractor furnished material sources, staging areas, plant sites, turnaround areas, or any other contractor caused ground disturbance outside the right-of-way and not shown in the plans are the Contractor's responsibility and shall be submitted under a different NOI package from the ground disturbance within right-of-way and shown on the plan sheet details. As these separate Stormwater General Permits are the sole responsibility of the Contractor, NDOT shall not be listed as an Owner or Operator. Provide a copy of all separate signed NOI certification statements. The Department is not responsible for delays caused by incomplete or inaccurate submittals to NDEP by the Contractor.

The Contractor is solely liable for any suspension of work due to regulatory agency, e.g. NDEP, enforcement actions resulting from permit, e.g. Stormwater General Permit NVR100000, non-compliance.

Land disturbance areas beyond those depicted in the contract documents resulting from Contractor construction activities shall undergo final stabilization at the Contractor's expense. These include, but are not limited to, unidentified staging areas, turnaround areas, employee parking areas, and areas of ingress and egress. Submit final stabilization plans for Departmental review and approval.

**637.03.02 Dust Control.** Develop, obtain, and pay for all State and local entity permits and fully comply with the terms specified therein. Furnish and apply water or chemical dust palliative for controlling dust on the areas designated and according to permit conditions. Use equipment and obtain water as specified in Subsection 107.21.

Control dust originating from traffic, plant, or construction operations either inside or outside the right of way at all times according to Federal, State, and local laws, ordinances, and regulations.

Use dust palliatives listed in the QPL. Consult the Manual fact sheets for appropriate product selection.

Mix and apply dust palliative as recommended by the manufacturer. Prepare the soil for application of dust palliative according to manufacturer instructions. Apply additional applications of dust palliative to control dust or as required by air quality regulating authorities.

Maintain all disturbed areas in a condition to prevent wind erosion and particulate emissions 24 hours a day, 7 days a week until the construction site is completely stabilized as shown on the plans and as required.

For contracts in Clark County, provide a copy of the Clark County Department of Air Quality Management "Dust Control Permit" for construction activity prior to beginning work. Provide a copy of the final inspection and release from the Clark County Department of Air Quality Management "Dust Control Permit" upon completion of construction activities.

Immediate notification will be given in writing for failure to maintain adequate dust control and may result in immediate suspension of construction operations. If failing to remedy unsatisfactory dust control within 1 hour after receipt of such notice, the Engineer may immediately proceed to take necessary action to maintain dust control and the entire cost of this maintenance will be deducted from money due or to become due.

## METHOD OF MEASUREMENT

**637.04.01 Measurement.** Temporary pollution control will be measured by the lump sum.

Dust control will be measured by the lump sum.

## BASIS OF PAYMENT

**637.05.01 Payment.** The accepted quantities, measured as provided above, will be paid for at the contract price bid per unit of measurement for the pay items listed below that are shown in the proposal. Payment will be full compensation for the work prescribed in this Section.

Payment for temporary pollution control by the lump sum will be full compensation for all work required in this Section, with the exception of dust control. Payment for dust control will be made separately.

Partial payments for temporary pollution control and dust control will be made as the work progresses. The Engineer will determine the reasonable payment percentage for each payment cycle. When requested, furnish invoices and receipts for actual costs. The amount paid on the next progress payment will be 50% of the amount determined. The remaining percentage will be prorated according to job progress. However, if temporary pollution control or dust control become inadequate, payment will cease and the provisions of Subsection 637.03.02 may be enforced.

A maximum amount of 5% of the original contract amount will be paid for temporary pollution control during the progress of the work. Upon completion of all work on the project, payment of any amount bid for temporary pollution control in excess of 5% of the original contract amount will be paid.

A maximum amount of 5% of the original contract amount will be paid for dust control during the progress of the work. Upon completion of all work on the project, payment of any amount bid for dust control in excess of 5% of the original contract amount will be paid.

Payment will be made under:

| Pay Item | Pay Unit |
|---|---|
| Temporary Pollution Control | Lump Sum |
| Dust Control | Lump Sum |

# SECTION 640

## RETAINING WALLS

### DESCRIPTION

**640.01.01 General.** This work consists of constructing masonry block retaining walls.

### MATERIALS

**640.02.01 General.** Material shall conform to the following Sections and Subsection:

| | |
|---|---|
| Portland Cement Concrete | Section 501 |
| Reinforcing Steel | Section 505 |
| Portland Cement | Section 701 |
| Grout and Mortar Aggregate | Subsection 706.03.04 |
| Water | Section 722 |

Unless otherwise specified, use Class A or Class AA concrete. Class D may be substituted for Class A concrete or Class DA may be substituted for Class AA concrete.

Masonry block shall be slump block or split face block of the dimensions shown on the plans and conforming to ASTM C90, Type I.

Add an integral color pigment to all concrete block and mortar, except the grout used in filling cells. The color pigment shall consist of a synthetic mineral oxide specifically manufactured for coloring masonry products and mortar. Obtain the integral coloring by mixing the pigment material with the other ingredients in a sequence and by methods that will result in a uniform color.

Unless otherwise indicated on the plans, the color of the concrete blocks and mortar shall approximate Federal Standard No. 37875 as shown in Table VIII of Federal Standard No. 595B. The final color selections will be subject to approval.

The polyvinyl chloride premolded joint filler shall conform to Subsection 707.03.03 (c).

### CONSTRUCTION

**640.03.01 General.** Give not less than 10 days notification in advance of shipment of concrete blocks to the jobsite for testing before shipment.

Provide a separate storage area for concrete blocks which have been tested and accepted but are stockpiled for later delivery to the jobsite.

Construct footings according to Section 502.

Compose mortar for masonry walls of 1 part Portland cement to not more than 3 parts surface dry mortar aggregate by volume, to which hydrated lime may be added in the quantity of 25% by volume of cement. Treat hydrated lime as an addition to and not as replacing any cement. Hydrated lime shall conform to ASTM C207, Type S. Prepared mortar mix may be substituted if approved.

All grout used to fill cells shall attain a minimum compressive strength of 17 MPa (2,500 psi) in 28 days when tested according to Test Method No. Nev. T427.

Construct the masonry wall true and plumb. Lay straight uniform courses in common bond with vertical joints aligned over center of unit below as shown on the drawings. Align all vertical cells.

Mortar joints shall be 9.5 mm (0.375 in.) thick. Lay all blocks with horizontal and vertical mortar joints buttered along face edges for a depth equal to thickness of face shells, also on the webs surrounding the cells to be filled. Shove vertical joints tight. Concave tool joints smooth. Keep all wall surfaces clean and free from mortar blotches.

Place reinforcement as shown on the plans.

Solidly fill cells with grout according to the details shown on the plans.

At the conclusion of the masonry work, remove mortar daubs and smears and clean down the walls.

Take precautions when constructing the masonry walls when the temperature is below 4 °C (40 °F). Provide suitable materials to heat materials, protect the work from cold and frost, and to insure that mortar or grout will harden without freezing.

## METHOD OF MEASUREMENT

**640.04.01 Measurement.** Masonry retaining walls will be measured by the square meter (square foot), measured along the face of the wall, on the masonry block portion placed above the top of the footing.

Concrete in footings for masonry retaining walls will be measured and paid for according to Section 502.

Reinforcement in masonry block walls and masonry block wall footings will be measured and paid for according to Section 505.

Structure excavation and granular backfill will be measured and paid for according to Sections 206 and 207.

## BASIS OF PAYMENT

**640.05.01 Payment.** The accepted quantities, measured as provided above, will be paid for at the contract price per unit of measurement for the pay items listed below that are shown in the proposal. Payment will be full compensation for the work prescribed in this Section.

Payment will be made under:

| Pay Item | Pay Unit |
|---|---|
| Masonry Retaining Wall | Square Meter (Square Foot) |

# SECTION 641

## VEHICULAR IMPACT ATTENUATORS

DESCRIPTION

**641.01.01 General.** This work consists of furnishing and installing impact attenuator systems.

MATERIALS

**641.02.01 General.** Select approved impact attenuators from the manufacturers listed in the QPL. Use the impact attenuator selected for the entire project and do not use a combination of types of impact attenuators.

Impact Attenuator (Special) shall meet all the requirements of this Section except the type and configuration of the unit will be specified in the Special Provisions.

Concrete used in the foundation slabs shall have a minimum compressive strength of 28 MPa (4,000 psi) and shall conform to Section 501. Reinforcing bars used in the concrete base slabs shall be Grade 420 (60) conforming to Section 505.

Submit for approval the manufacturer's shop drawings, foundation details, installation recommendations, and any other pertinent information for the impact attenuator. Receive approval for the exact model of impact attenuator proposed, prior to installation.

Furnish and install the units with all parts and materials necessary for them to perform as designed.

CONSTRUCTION

**641.03.01 General.** Excavate any material encountered for the construction of base slabs according to Section 206.

Furnish and install aggregate base, reinforcing steel, concrete, backfill, asphalt pavement, anchor bolts, miscellaneous hardware, epoxy, reflectors on the nose sections, and any other incidentals required for construction of the attenuators.

Construct concrete and metal reinforcement items according to Sections 502 and 505.

Install impact attenuators according to the plans and the manufacturer's recommendations.

METHOD OF MEASUREMENT

**641.04.01 Measurement.** Impact attenuators will be measured by the each.

BASIS OF PAYMENT

**641.05.01 Payment.** The accepted quantities, measured as provided above, will be paid for at the contract price per unit of measurement for the pay items listed below that are shown in the proposal. Payment will be full compensation for the work prescribed in this Section.

Payment will be made under:

| Pay Item | Pay Unit |
|---|---|
| Impact Attenuator | Each |
| Impact Attenuator (Special) | Each |

# SECTION 642

## MECHANICALLY STABILIZED EARTH WALLS

DESCRIPTION

**642.01.01 General.** This work consists of constructing mechanically stabilized earth (MSE) walls consisting of precast concrete panel or segmental blocks with metallic or geogrid soil reinforcements.

**642.01.02 Design Requirements.** Design MSE retaining walls and ancillary elements associated with the walls in accordance with the plans and as specified herein.

Design MSE walls for a minimum service life of 100 years.

Maximum reinforcement loads shall be calculated using the “Simplified Method” according to Subsection 11.10.6.2 of the AASHTO LRFD Bridge Design Specifications.

Design and detail base drains and back drains to collect and remove groundwater before it can enter the reinforced backfill of MSE retaining walls. Installation of the drainage system shall occur only during the placement of MSE backfill.

Provide a constant length of all reinforcement layers within a design section to form a uniform reinforced soil mass, with the exception of the top two layers of reinforcement. Provide the top two layers of reinforcement with a length of reinforcement that is 1.5 m (5 ft) longer than all other layers below.

For geogrid reinforcement layers, provide a reinforcement coverage ratio of 1.0 according to Subsection 11.10.6.4 of the AASHTO LRFD Bridge Design Specifications.

Where concrete panel walls or wall sections intersect with an interior angle of 130 degrees or less, provide a special vertical corner element panel. The corner element panel shall cover the joint of the panels that abut the corner and allow for independent movement of the abutting panels.

Geometry of the MSE walls shown on the plans is based on the external stability of the wall system as determined by the Department. Be responsible for the internal design of the wall based on the design requirements. Design shall include verification of external stability, internal stability, design of concrete wall panel, and corrosion analysis for metallic soil reinforcements. Incorporate proposed highway surface drainage installations and other project specific requirements into the wall design. Top of wall elevation and alignment shall remain as shown on the plans regardless of the wall system selected. Depth of wall embedment or length of reinforcement may be increased as required by internal design.

Fully document all loading conditions and assumptions used for the wall design. Consider all load cases that may be anticipated to exist during construction and during the service life of the wall due to surcharges, hydraulic conditions, live loads, combinations of the preceding, and obstructions within the reinforced backfill.

For each wall design section, provide a design summary that includes design section identification, location, wall geometry (height, backslope, etc.), loadings (traffic loading, hydrostatic, seismic, traffic barrier, etc.), governing design resistance factors and level where they occur, and other pertinent information.

**642.01.03 Installer Qualifications.** Provide an on-site supervisor having experience in the construction of at least five transportation related MSE walls within the last three years. Transportation related MSE walls are defined as walls that carry or are adjacent to vehicular traffic and are constructed with MSE reinforcement in the reinforced structure backfill zone.

The on-site supervisor shall have prior experience with the type of wall that will be constructed. The on-site supervisor shall be on the job site the entire time the wall is being constructed.

Submit verification of the on-site supervisor’s qualifications containing a summary of the individual’s experience and the respective projects at least 30 days prior to beginning wall construction. Do not begin wall construction until the supervisor’s qualifications have been approved.

**642.01.04 Submittals.** Submit working drawings, calculations, and construction manuals according to Subsection 105.02. Working drawings and calculations shall be prepared and stamped by a registered Civil Engineer licensed in the State of Nevada.

Do not begin wall construction until submittals have been approved.

**642.01.05 Pre-Activity Meeting.** Before commencement of MSE wall construction, the Engineer may designate a time and place satisfactory to the Contractor for a pre-activity meeting. The pre-activity meeting shall be held not more than 2 weeks in advance of the scheduled wall construction. The approved on-site supervisor and the MSE wall manufacturer's technical representative shall be present at the pre-activity meeting.

Do not commence wall construction until all issues raised at the pre-activity meeting have been addressed to the Engineer's satisfaction.

MATERIALS

**642.02.01 General.** Material shall conform to the following Sections:

Portland Cement Concrete ..... Section 501
Reinforcing Steel ..... Section 505
Portland Cement ..... Section 701
Water ..... Section 722

Wall systems are patented. Provide for such use by suitable legal agreement with the patentee and pay all costs connected therewith.

Portland cement concrete for leveling pads and panels for installations in Clark County shall be Class A Modified. Concrete shall be Class AA Modified for all other locations. Concrete shall have a minimum 28 day compressive strength of 31 MPa (4,500 psi) or as otherwise shown on the plans.

The geotextile shall be a woven, 100% monofilament fabric and conform to the following:

| PROPERTY | TEST METHOD | REQUIREMENT |
|---|---|---|
| Survivability | AASHTO M288 | CLASS 2 |
| Permittivity | ASTM D4491 | $\geq$ 0.5 $sec^{-1}$ |
| Apparent Opening Size (AOS) | ASTM D4751 | 0.43 mm Maximum |
| Ultraviolet Stability @ 500 hr, Strength Retained | ASTM D4355 | $\geq$ 90 % |

**642.02.02 Concrete Panel Wall.** Use concrete panel wall systems listed in the QPL.

Install panel joint bearing pads of the dimensions and thickness shown in the approved working drawings. Ensure that bearing pads placed in horizontal joints between panels are preformed Ethylene Propylene Diene Monomer (EPDM) rubber pads. Submit a manufacturer's certification that the bearing pad material conforms to ASTM D2000 Grade 2, Type A, Class A with a Durometer Hardness of 55 ± 5, or High Density Polyethylene (HDPE) pads with a minimum density of 0.946 $g/cm^3$ in accordance with ASTM D1505. Determine the stiffness (axial and lateral), size, and number of bearing pads such that the final joint opening shall be 19 ± 6 mm (0.75 ± 0.25 in.).

As part of the working drawing submittal, provide substantiating calculations verifying the stiffness (axial and lateral), size, and numbering of bearing pads assuming, as a minimum, a vertical loading at a given joint equal to 2 times the weight of facing panels directly above that level. As part of the substantiating calculations, submit results of certified laboratory tests in the form of vertical load-vertical strain and vertical load-lateral strain curves for the specific bearing pads proposed. The vertical load-vertical strain curve shall extend beyond the first yield point of the proposed bearing pad.

Maximum area of typical individual panels shall be 4.65 $m^2$ (50 $ft^2$), unless otherwise shown on the plans.

Cast the panels on a flat area. Do not contact or attach the coil embedments, tie strip guides, or other galvanized devices to the panel reinforcing steel.

Use clear form oil of the same manufacture throughout the casting operation.

Place the concrete in each unit without interruption and consolidate by the use of an approved vibrator, supplemented by such hand-tamping as may be necessary to force the concrete into the corners of the forms and prevent the formation of stone pockets or cleavage planes.

Cure the panels according to Subsection 501.03.08. Panels exhibiting shrinkage cracking due to improper curing will be rejected.

The front face surface shall have an approved finish and the rear face an unformed surface finish. Roughly screed the rear face of the panel to eliminate open pockets of aggregate and surface distortions in excess of 6 mm (0.25 in.).

When shown on the plans, construct the exposed face of wall panels with an architectural finish. Before casting the panels, furnish sufficient test panels to assure that the proper architectural finish has been obtained. The size of test panels shall be the same dimensions intended for use in the wall installation.

Manufacture panels within 5 mm (0.2 in.) of all dimensions.

Angular distortion with regard to the height of the panel shall not exceed 5 mm (0.2 in.) in 1.5 m (5 ft).

Surface defects on formed surfaces measured on a length of 1.5 m (5 ft) shall not exceed 2.5 mm (0.1 in.).

Acceptance of the panels with respect to compressive strength will be determined on a lot basis. The lot will consist of all production units (batches of concrete or panels) produced within a week's or 7 day production operation. Production units will be randomly selected according to the production day sample sizes of Table A and tested for compressive strength. Compression tests will be made on standard test specimens prepared according to Test Method No. Nev. T428. Compressive strength testing will be conducted according to ASTM C39.

**TABLE A**

| Production Day Quantities | Sample Size |
|---|---|
| <25 $m^3$ (<35 $yd^3$) (<50 panels) | 1 |
| 25-50 $m^3$ (35-70 $yd^3$) (50-100 panels) | 2 |
| 51-115 $m^3$ (71-150 $yd^3$) (101-150 panels) | 3 |
| >115 $m^3$ (>150 $yd^3$) (>150 panels) | 5 |

When standard test specimens are utilized, a minimum of 5 cylinders will be cast for each production unit sampled. Two of these specimens will be cured in the same manner as the panels and tested at 7 days for determining the strength for shipping and placing the panels. The remaining 3 cylinders will be cured according to Test Method No. Nev T428, Section D.1. and tested at 28 days. A test result will be the average compressive strength of 3 cylinders at 28 days.

Acceptance of the lot will be made if all acceptance tests in a lot are greater than 31 MPa (4,500 psi) or provided no individual 28 day compressive strength test result falls below 28 MPa (4,000 psi) and the average 28 day compressive strength of all test results for the lot equals or exceeds the acceptance limits set forth in Table B.

The acceptance limits of Table B shall also apply to core compressive strength tests results.

**TABLE B**

| Number of Lot Acceptance Tests | Lot Acceptance Limits, MPa (psi) |
|---|---|
| 3 – 7 | 31 + 0.33 R* (4,500 + 0.33 R*) |
| 8 – 15 | 31+ 0.44 R* (4,500 + 0.44 R*) |
| >15 | 31 + 0.46 R* (4,500 + 0.46 R*) |

* R is the difference between the largest and smallest acceptance test result.

Units will be subject to rejection due to failure to meet any of the requirements specified above. Panels that are cracked, severely chipped, have defects indicating imperfect molding, or have honeycombed or open texture concrete will be subject to rejection.

Clearly mark the date of manufacture, production lot number, and piece mark on the rear face of each panel.

Handle, store, and ship panels in such a manner as to prevent chipping, cracks, fractures, and excessive bending stresses. Support panels in storage on firm blocking to protect the panel connection devices and the exposed exterior finish.

**642.02.03 Segmental Block Wall.** Use segmental block wall systems listed in the QPL.

Cementitious materials and aggregates for segmental blocks shall conform to the requirements of ASTM C1372 Sections 4.1 and 4.2.

The blocks shall be visually efflorescence free. Use an efflorescence control agent in the concrete mix design.

Segmental blocks shall comply with the following requirements:

| TEST | TEST METHOD | REQUIREMENT |
|---|---|---|
| Compressive Strength | ASTM C140 | 34.5 MPa (5000 psi) Minimum |
| Water Absorption, % | ASTM C140 | 6 Maximum |
| Freeze-Thaw Loss, %:<br>40 cycles, 5 of 5 samples passing<br>or<br>50 cycles, 4 of 5 samples passing | ASTM C1262 (3% saline solution) | 1.5 Maximum<br>or<br>2.0 Maximum |

Furnish certified test reports from an independent testing laboratory for each lot of segmental blocks demonstrating conformance to the requirements listed above. A lot shall consist of any number of segmental blocks of any configuration or dimension manufactured by a producer using the same materials, concrete mix design, manufacturing process and curing method. Certified test results for representative block lots shall not have been conducted more than 12 months prior to jobsite delivery.

The certified test report shall clearly identify the firm conducting the sampling and testing, the type of block, the date sampled, name of the person who conducted the sampling, the represented lot, the number of blocks in the lot, and the specific test results for each of the stated requirements of this specification.

Do not use blocks without supporting certified test reports.

Cast the blocks in steel molds and in a manner that will ensure uniform production. Place the concrete in each block without interruption and consolidate.

Do not ship blocks until they obtain a minimum compressive strength of 28 MPa (4,000 psi).

Use a single style block type of approved color and surface texture throughout each wall.

Provide a top course of facing units composed of solid precast concrete units designed to be compatible with the remainder of the wall. Bond the finishing course to the underlying facing units with a durable, high strength, flexible adhesive compound compatible with the block material.

Blocks shall have a minimum depth (front face to back face) of 200 mm (8 in.). The minimum front face thickness of blocks shall be 100 mm (4 in.) measured perpendicular from the front face to inside voids greater than 25 $cm^2$ (4 $in.^2$). The minimum thickness of any other portion of the block shall be 50 mm (2 in.).

Manufacture blocks such that the length and width of each block is within 3 mm (1/8 in.) and the height is within 1.5 mm (1/16 in.) of the standard values published by the manufacturer.

When a broken or fractured face is required, the horizontal dimension of the front face shall be within 25 mm (1 in.) of the theoretical dimension of the individual block shown on the plans.

Any of the following defects will be sufficient cause for rejection of the blocks:

1. Imperfect molding, honeycomb, or open texture concrete.
2. Cracks wider than 0.5 mm (0.02 in.) and longer than 25% of the height of the block.
3. Severely chipped or broken blocks.
4. Color variation on front face of block due to excess form oil or other reasons.
5. Defective or damaged reinforcement connection devices built into the block.

Handle, store, and ship blocks in such a manner as to avoid chipping, discoloration, cracks, or fractures.

**642.02.04 Mechanically Stabilized Earth Backfill.** Backfill shall be free from organic and otherwise deleterious materials and conform to the following requirements for the type of reinforcement used:

| | Percent Passing by Mass | |
|---|---|---|
| **Sieve Size** | **Metallic Reinforcement** | **Geogrid Reinforcement** |
| 100 mm (4 in.) | 100 | — |
| 19 mm (3/4 in.) | — | 100 |
| 425 µm (No. 40) | 0-60 | 0-60 |
| 75 µm (No. 200) | 0-15 | 0-15 |

| | | Requirement | |
|---|---|---|---|
| **Project Control and Source Requirement Tests** | **Test Method** | **Metallic Reinforcement** | **Geogrid Reinforcement** |
| Sieve Analysis | Nev. T206 | Above | Above |
| Sampling Aggregate | Nev. T200 | — | — |
| Plasticity Index | Nev. T212 | 6 Max. | 6 Max. |
| Liquid Limit | Nev. T210 | 35 Max. | 35 Max. |
| pH | AASHTO T289 | 5.0-10.0 | 4.5-9.0 |
| Resistivity * | AASHTO T288 | 3000 ohm•cm Min. | — |
| Chlorides | AASHTO T291 Method A | 100 ppm Max. | — |
| Sulfates | AASHTO T290 Method B | 200 ppm Max. | — |

* When the resistivity exceeds 5000 ohm-cm, the Chlorides and Sulphates requirements are waived.

Backfill shall have a coefficient of uniformity, Cu, that is greater than 4 as determined by ASTM D2487.

The backfill shall exhibit an angle of internal friction of not less than 34 degrees, as determined by the Standard Direct Shear Test, AASHTO T236, on the portion finer than the 2 mm (No. 10) sieve, utilizing a sample of the material compacted to 95% of AASHTO T99, Method C or D, at the optimum moisture content. No direct shear testing is required for backfills where 80 percent or more of the material is larger than 19 mm (3/4 in.). The materials shall be substantially free of other soft, poor durability particles. The material shall have a magnesium sulfate soundness loss of less than 30% after four cycles or a sodium sulfate soundness loss of less than 15% after five cycles when tested according to AASHTO T104. The portion of the material finer than the 2 mm (No. 10) sieve shall not have an organic content of more than 1% as measured according to AASHTO T267. Furnish a certificate of compliance and test report by an AASHTO accredited laboratory, certifying that the MSE backfill material complies with requirements of the internal friction angle and the magnesium sulfate soundness. A minimum of two samples at two different locations shall have these two tests conducted.

If the measured backfill friction angle in laboratory tests is greater than 38 degrees, the friction angle used for design shall be limited to 38 degrees.

Acceptance tests for the requirements of the backfill, except internal friction angle and magnesium sulfate soundness, will be performed by the Department.

Produce and separate backfill aggregate into individual stockpiles containing no less than 190 $m^3$ (250 $yd^3$) and no more than 7,650 $m^3$ (10,000 $yd^3$). Each designated stockpile will be sampled a minimum of 10 days prior to placement. Do not use stockpiled material until given approval.

**642.02.05 Metallic Soil Reinforcement.** Fabricate the soil reinforcing system to the dimensions and tolerances shown on the approved working drawings.

Design metallic reinforcements and connection hardware using the time dependant corrosion loss rates specified in Subsection 11.10.6.4 of the AASHTO LRFD Bridge Design Specifications.

Steel strip-type soil reinforcement and steel connection hardware shall be hot-dip galvanized after fabrication in accordance with AASHTO M111 (ASTM A123). Bar mat or grid-type soil reinforcement shall be galvanized after fabrication in accordance with ASTM A641. Provide a minimum galvanized coating of 605 $g/m^2$ (2.0 $oz/ft^2$) or 85 µm (3.4 mils) in thickness. Adequately support steel soil reinforcement while lifting and placing such that the galvanization remains intact. Repair damage to galvanized coatings in accordance with ASTM A780.

Steel strip reinforcement shall be hot rolled to the required shape and dimensions. The steel shall conform to ASTM A572, Grade 65.

Welded wire reinforcing for bar mat or grid-type reinforcement shall conform to ASTM A1064.

Steel tie strips shall be hot rolled steel conforming to ASTM A1011, Grade 50 minimum. The minimum bending radius of the tie strips shall be 9.5 mm (3/8 in.).

Connection hardware shall conform to the requirements shown in the approved working drawings. Connection hardware shall be cast in the precast concrete panels such that all connectors are in alignment and able to transfer full and even load to the reinforcement. Once the reinforcement is connected to the panel, the amount of slack shall not exceed 3 mm (1/8 in.) between the connector and the reinforcement during field installation. Fasteners shall be hot-dipped galvanized and conform to the requirements of AASHTO M164 (ASTM A325).

**642.02.06 Geogrid Soil Reinforcement.** Geogrid soil reinforcement shall be as previously approved on the QPL for either concrete panel or segmental block wall systems.

Submit a manufacturing quality control certificate and conformance testing results for geogrid soil reinforcement delivered to the site. Perform sampling and conformance testing according to ASTM D4354. Base geogrid product acceptance on ASTM D4759. For geogrid soil reinforcement, provide conformance testing of ultimate tensile strength, $T_{ult}$. The quality control certificate shall include roll numbers and identification, sampling procedures, and results of the conformance testing with a description of test methods used. Include a signed certification that geogrid soil reinforcement is in conformance with these specifications with the submitted quality control certificate.

## CONSTRUCTION

**642.03.01 General.** Grade the foundation for the limits of the MSE wall as indicated on the plans and working drawings. Compact the foundation to not less than 95% of the maximum density as determined by Test Method No. Nev. T108. The in-place density will be determined by Test Method No. Nev.T102 or T103. Remove foundation soils found to be unsuitable or incapable of sustaining the required compaction and replace with mechanically stabilized earth backfill.

Construct concrete leveling pads according to Section 502.

Construct leveling pads at the foundation level of the facing elements. Cure the pad for a minimum of 12 hours before placement of facing elements.

Construct the top surface of the leveling pad so it is level in both directions. The leveling pad shall not deviate from level by more than 3 mm (1/8 in.) in 3 m (10 ft), except at designated steps in the leveling pad shown on the plans or accepted working drawings.

Install an internal drainage system behind the wall as indicated on the plans and working drawings. Place outlet pipes at sags in the flow line, at the low end of the collector pipe, and at other locations as shown or specified. Determine the location and elevation of the internal drainage system and include the details in the working drawings. Form openings for weepholes in precast facing panels prior to casting the panels.

Have the wall manufacturer’s technical representative present for the pre-activity meeting and during the construction of the first row of facing elements for each wall and as directed. Incorporate changes to the wall installation procedures as recommended by the technical representative. For each day the technical representative is on site, submit an activity report prepared by the technical representative and signed by the contractor documenting that the observed work in progress conforms to the manufacturer’s recommended installation procedures and providing any recommendations for revisions to the installation procedures.

Regardless of allowable wall tolerances, do not construct walls with a negative slope or batter (sloping away from the retained soil).

Do not drill or drive posts (sign, guardrail, etc.) or other roadside hardware through the reinforced backfill after placement of backfill.

Install the soil reinforcement in accordance with the wall manufacturer's recommendations, the plans, approved working drawings, and as specified herein. Place the reinforcement within the layers of the compacted backfill material at the locations shown in the working drawings. Only place that amount of reinforcement required for immediately pending work to prevent undue damage. Place reinforcement with the strongest direction oriented perpendicular to the wall face, unless otherwise shown in the working drawings. Connect the reinforcement to the wall facing as indicated in the details included in the approved working drawings. Lay the reinforcement flat and uniformly tension to remove slack in the connection or reinforcement material. After the reinforcement is connected to the panel, the amount of slack shall not exceed 3 mm (1/8 in.) between the connector and the reinforcement during installation. Where wall geometry causes soil reinforcement to overlap, provide a minimum vertical separation of 75 mm (3 in.) between overlapping reinforcements.

Backfill placement shall closely follow the erection of each course of panels. Cover reinforcement with backfill during the same work shift that it is placed. At each reinforcement level, roughly level backfill before placing and fastening the soil reinforcement. Place the backfill in uniform horizontal layers not exceeding 200 mm (8 in.) in loose thickness before compaction. Place backfill in horizontal layers not exceeding 150 mm (6 in.) if using hand-operated compaction equipment. Moisten each layer of backfill as necessary and thoroughly compact to achieve the patentee's required percentage of maximum density or 95% of maximum density, whichever is greater, as determined by Test Method No. Nev. T108. The in place density will be determined by Test Method No. Nev. T102 or T103.

Place backfill in such a manner to avoid damage or disturbance to the wall materials or misalignment of the facing elements. Do not operate construction equipment directly on reinforcement. Maintain a layer of backfill at least 150 mm (6 in.) thick between reinforcement and any construction equipment.

Backfill shall extend to at least 300 mm (12 in.) beyond the free end of the reinforcement.

Do not use sheepsfoot or grid-type rollers for compacting MSE backfill.

Compact backfill material located within 1 m (3 ft) of the back face of the wall or a backfill penetration (pile, drainage structure, etc.) using a minimum of three passes of a lightweight walk behind vibratory plate or roller. Ensure that voids do not exist beneath reinforcing elements at the back face of the wall. The moisture content of the backfill material prior to and during compaction shall be uniform.

At the end of each day's operations, shape the last level of backfill to direct surface runoff away from the wall face. In addition, do not allow surface runoff from adjacent areas to enter the wall reinforcement zone until this zone is protected from infiltration. Repair damage or movement caused by erosion, sloughing, or saturation of the reinforced backfill.

**642.03.02 Concrete Panel Wall.** Construct concrete panel walls as described in the wall manufacturer's approved construction manual and as described herein.

Construct copings according to Section 502.

Do not place panels prior to the panels reaching an age of 7 days and a compressive strength of at least 85% of the specified 28 day strength requirement.

Handle panels by a lifting device set into the upper edge of the panels or as indicated in the working drawings.

Place the first course of panels directly on the leveling pad. Provide external bracing for the first lift of panels. As backfill material is placed, maintain the panel in position by means of temporary wooden wedges and clamps or bracing in accordance with the wall manufacturer's recommendations. Remove the wedges as soon as the panel above the wedged panel is completely installed and backfilled.

Place panels in successive horizontal lifts in the sequence shown on the working drawings as backfill placement proceeds. Adjust panel bracing procedures as necessary to provide the vertical and horizontal alignment shown on the plans and working drawings and conforming to the specified tolerances.

Repair damage to installed panels as directed.

Final panel joint openings shall be 19 mm ± 6 mm (3/4 ± 1/4 in.).

Place geotextile over all panel joints on the back face of the wall including the joint along the leveling pad. The geotextile shall have a minimum width of 300 mm (12 in.) and shall be centered over the joint. Overlap intersecting geotextile layers a minimum of 100 mm (4 in.). Install the geotextile fabric by applying adhesive to the back of the panel on each side of the joint. Do not apply adhesive directly on the geotextile fabric or within 50 mm (2 in.) of the panel joint edge.

Vertical tolerances and horizontal alignment tolerances shall not exceed 19 mm (3/4 in.) when measured along a 3 m (10 ft.) straight edge at any location along the wall. The overall vertical tolerance of the wall (plumbness from top to bottom) shall not exceed 12.5 mm (1/2 in.) per 3 m (10 ft) of wall height. The allowable out of plane offset between panels at the joint shall not exceed 9.5 mm (3/8 in.).

**642.03.03 Segmental Block Wall.** Construct segmental block walls according to the approved working drawings and the manufacturer's construction manual.

Do not stockpile or store materials or large equipment within 3 m (10 ft) of the front face of the wall.

Construct the leveling pad as wide as the proposed blocks or a minimum of 300 mm (12 in.). The bottom row of blocks shall be level and in full bearing with the leveling pad.

For walls that are less than or equal to 1.5 m (5 ft) in height, a 300 mm (12 in.) deep by 600 mm (24 in.) wide leveling pad constructed from Type 1 Class B Aggregate Base compacted to 95% according to Section 302 may be used. If any portion of the wall is over 1.5 m (5 ft) in height, use a concrete leveling pad for the entire length of the wall.

Place segmental blocks in successive horizontal lifts in the sequence shown on the approved working drawings.

Level the first row of blocks from block-to-block and from front-to-back. Place blocks such that they are snug or to within 1.5 mm (1/16 in.) together and parallel to the straight or curved line of the wall face. Dry-stack all blocks and place each block evenly spanning the joint in the row below (running bond). Shim or grind to control the elevations of any two adjacent blocks to within 1.5 mm (1/16 in.). Check the top of blocks with a minimum length of 1 m (3 ft) long straight edge bubble level. Grind high points identified by the straight edge. Check block front to back tilting frequently, and correct by shimming no later than after 3 completed courses.

Install all pins, rods, clips, or other devices used to develop mechanical interlock between block layers according to the approved working drawings and manufacturer's construction manual.

Fill formed voids or openings in the facing units with core fill consisting of a free-draining, coarse grained crushed stone or granular fill conforming to the following gradation:

| Sieve Size | Percent Passing by Mass |
|---|---|
| 38 mm (1.5 in.) | 100 |
| 25 mm (1 in.) | 75-100 |
| 19 mm (3/4 in.) | 50-75 |
| 4.75 mm (No. 4) | 0-60 |
| 425 µm (No. 40) | 0-50 |
| 75 µm (No. 200) | 0-5 |

Evaluate the core fill gradation at a frequency of 1 test per 38 $m^3$ (50 $yd^3$) and for every change in material source.

The minimum length of soil reinforcement measured from the back face of the wall shall be 70% of the wall height or as shown on the plans or approved working drawings. In no case shall this length be less than 2 m (6 ft). The soil reinforcement shall extend 1 m (3 ft) beyond the theoretical failure plane in all cases.

The maximum vertical spacing of soil reinforcement layers shall be two times the block depth (front face to back face) or 800 mm (32 in.), whichever is less. The first (bottom) layer of reinforcement shall be placed no further than 300 mm (12 in.) above the top of the leveling pad, but at least one block height above the leveling pad. The last (top) layer of soil reinforcement shall be no further than 600 mm (24 in.) below the top of the uppermost block.

Each geogrid layer shall be continuous throughout the lengths indicated on the plans. Join geogrid strips with straps, rings, hooks, or other mechanical devices to prevent movement during backfilling operations.

Provide a minimum width of 300 mm (12 in.) of core fill behind solid (non-hollow) block units. Place geotextile fabric between the unit (core) fill and the reinforced backfill.

Do not advance placement of backfill more than the height of the installed block layer until the drainage fill, unit (core) fill, and all fill in all openings within the blocks at that level have been placed. Sweep each layer of facing units clean of all debris before placing the next layer of facing units.

Vertical tolerances and horizontal alignment tolerances shall not exceed 19 mm (3/4 in.) when measured along a 3 m (10 ft) straight edge at any location along the wall. The overall vertical tolerance of the wall (plumbness from top to bottom) shall not exceed 32 mm (1 1/4 in.) per 3 m (10 ft) of wall height.

## METHOD OF MEASUREMENT

**642.04.01 Measurement.** Concrete leveling pads will be measured and paid for according to Section 502.

Structure excavation and granular backfill will be measured and paid for according to Sections 206 and 207.

Concrete panel walls will be measured by the square meter (square foot), measured on the exterior face of the wall from the top of footing to the top of the coping.

Copings for concrete panel walls will be measured by the linear meter (linear foot) along the top of the coping.

Concrete panel wall copings integrated with barrier rails or reinforced concrete slabs will be measured and paid for according to Sections 502 and 505.

Mechanically stabilized earth backfill will be measured by the cubic meter (cubic yard).

Limits of mechanically stabilized earth wall, mechanically stabilized earth backfill, coping, structure excavation, and granular backfill shown on the plans are based on external design requirements. Actual limits will be as shown on the approved submittals and no additional compensation will be allowed for quantity increases due to patentees' internal requirements.

Segmental block walls will be measured by the square meter (square foot), measured on the exterior face of the wall from the bottom of the wall to the top of the wall.

## BASIS OF PAYMENT

**642.05.01 Payment.** The accepted quantities, measured as provided above, will be paid for at the contract price per unit of measurement for the pay items listed below that are shown in the proposal. Payment will be full compensation for the work prescribed in this Section.

Payment will be made under:

| Pay Item | Pay Unit |
|---|---|
| Concrete Panel Wall | Square Meter (Square Foot) |
| Mechanically Stabilized Earth Backfill | Cubic Meter (Cubic Yard) |
| Coping | Linear Meter (Linear Foot) |
| Segmental Block Wall | Square Meter (Square Foot) |

# SECTION 643

## GROUND ANCHORS

DESCRIPTION

**643.01.01 General.** This work consists of constructing ground anchors for retaining walls.

**643.01.02 Qualifications.** Prepare a project reference list verifying the successful construction completion of at least 6 permanent ground anchor retaining wall projects during the past 3 years totaling at least 250 ground anchors. Include a brief description of each project including the location, number of anchors, and the Owner's name, address, and current phone number.

Provide a Nevada Registered Professional Engineer, employed by the ground anchoring Contractor and having experience in the construction of ground anchor retaining walls on at least 6 completed projects during the past 3 years, to supervise the work and prepare submittals. Consultants or manufacturer's representatives will not be allowed to satisfy the aforementioned requirement. Use an on-site supervisor and drill rig operators having experience installing ground anchors on at least 4 projects over the past 2 years. Prepare a personnel qualifications list containing a summary of each individual's experience and the respective projects.

**643.01.03 Submittals.** Submit 5 copies of the following information for review and approval at least 30 days prior to beginning wall construction:

1. Project reference list and personnel qualifications list.

2. Proposed start date and detailed wall construction sequence.

3. Plan describing diversion, control, and disposal of surface water.

4. Proposed methods and equipment for excavating the soil and/or rock.

5. Ground anchor schedule indicating each ground anchor number, ground anchor design load, type and size of tendon, total anchor length, bond length, and minimum unbonded length.

6. If applicable, description of space requirements for installation equipment, temporary shoring plans, and provisions for working in the proximity of underground facilities or utilities.

7. Drawing of the ground anchor tendon including details for spacers and their location, centralizers, unbonded length corrosion protection system, bond length corrosion protection system, anchorage and trumpet, and anchorage corrosion protection system.

8. Grout mix design including type and source of cement, water-cement ratio, and brand name and technical literature for proposed admixtures. Furnish test results, supplied by a qualified independent testing lab, verifying the specified minimum compressive strength. For mix design approval, trial batch strength results shall be 15% greater than the specified strength. Previous test results for the proposed grout mix completed within one year of the start of grouting may be submitted for review and approval.

9. Proposed grout placement procedures and equipment.

10. Identification number and certified calibration records for each test jack and pressure gauge and load cell to be used. Calibration records shall include the date tested, device identification number, and the calibration test results.

11. Manufacturer Certificates of Compliance for the prestressing steel (strand or bar), hardware, bearing plates, and corrosion protection system as specified in Subsection 106.05.

Approval or rejection of the submittals will be given within 30 days after receipt of a complete submission. Do not begin wall construction or incorporate materials into the work until the submittal requirements are satisfied and found acceptable. Changes or deviations from the approved submittals must be re-submitted for approval. No adjustments in contract time will be allowed due to incomplete submittals or for submittals returned for corrections.

Upon delivery of the prestressing steel and the bearing plate steel to the project site, provide certified mill test results from each heat lot specifying the ultimate strength, yield strength, elongation, and composition.

Furnish all records documenting the wall construction. Provide as-built drawings within 20 days after completion of the ground anchor work showing the location and orientation of each ground anchor, anchor capacity, tendon type, total anchor length, bond length, unbonded length, tendon bond length as installed, ground anchor test results and graphs, and grouting records indicating the cement type, quantity injected and the grout pressures.

MATERIALS

**643.02.01 General.** Materials shall conform to the following Sections:

Portland Cement ..... Section 701
Concrete Curing Materials and Admixtures ..... Section 702
Water ..... Section 722

Fabricate ground anchor tendons from single steel bars conforming to AASHTO M275, or from single or multiple elements of prestressing strands conforming to AASHTO M203 or ASTM A886.

Steel bar couplers shall be capable of developing 100% of the minimum specified ultimate tensile strength of the steel bar. Steel strands shall be continuous with no splices, unless approved.

Provide centralizers at maximum intervals of 3 m (10 ft) with the deepest centralizer located 0.3 m (1 ft) from the end of the anchor and the upper centralizer for the bond zone located no more than 1.5 m (5 ft) from the top of the tendon bond length. Use spacers to separate the steel strands of strand tendons. Spacers shall be placed at maximum intervals of 3 m (10 ft) and may be combined with centralizers.

Fabricate centralizers and spacers from plastic, steel, or other material which is nondetrimental to the prestressing steel. Wood centralizers or spacers will not be allowed. Design centralizers to support the tendon in the drill hole. Position the tendon so a minimum of 13 mm (1/2 in.) of grout cover is provided and to permit grout to freely flow around the tendon and up the drill hole.

Centralizers are not required on pressure injected anchors installed in coarse grained soils when the grouting pressure exceeds 1 MPa (150 psi), nor on hollow stem-augered anchors when they are grouted through the auger with grout having a slump of 225 mm (9 in.) or less.

Stressing anchorages shall be a combination of either a steel bearing plate with wedge plate and wedges, or a steel bearing plate with a threaded anchor nut. The steel bearing and wedge plate may also be combined into a single element. Anchorage devices shall be capable of developing 95% of the specified minimum ultimate tensile strength of the prestressing steel tendon. The anchorage devices shall conform to the static strength requirements of Section 3.1.6 (1) and Section 3.1.8 (1) and (2) of the latest edition of the PTI “Post Tensioning Manual.”

All of the tendon bond length shall be free of dirt, manufacturers’ lubricants, corrosion-inhibitive coatings, or other deleterious substances.

Fabricate trumpets from steel pipe conforming to ASTM A53, Schedule 40. Trumpets shall have a minimum wall thickness of 5 mm (0.20 in.) and shall be a minimum of 38 cm (15 in.) in length.

Fabricate bearing plates from steel conforming to AASHTO M270 Grade 250 (36) minimum or equivalent.

Weld the trumpet to the bearing plate and galvanize according to ASTM A153.

Design wedges to preclude premature failure of the prestressing steel due to notch or pinching effects under static and dynamic strength requirements of Section 3.1.6 (1) and Section 3.1.8 (1) and 3.1.8 (2) of the latest edition of the PTI “Post Tensioning Manual.” Do not reuse wedges.

Provide grout tubes with an adequate inside diameter to enable the grout to be pumped to the bottom of the drill hole. Grout tubes shall be strong enough to withstand a minimum grouting pressure of 1 MPa (150 psi). Postgrout tubes shall be strong enough to withstand postgrouting pressures.

Bondbreaker shall be fabricated from smooth plastic tube or pipe and shall enable the tendon to elongate during testing and stressing and allow the tendon to remain unbonded after lock-off. The material shall be nondetrimental to the tendon and capable of withstanding abrasion, impact, and bending during handling and installation. Use material resistant to aging by ultra-violet light and resistant to chemical attack from aggressive environments, grout, and corrosion inhibiting compounds.

Corrosion inhibiting compound placed in the free length area shall be an organic compound with the appropriate polar moisture displacing, corrosion inhibiting additives and self-healing properties. The compound shall permanently stay viscous and be chemically stable and nonreactive with the prestressing steel, the sheathing material, and the anchor grout.

Grout shall be neat Type V cement and water and shall be stable (bleed less than 2%), fluid, and provide a minimum compressive strength of at least 21 MPa (3,000 psi) at time of stressing.

Admixtures which control bleed, improve flowability, reduce water content, and retard set may be used in the grout subject to review and approval. Accelerators will not be permitted. Expansive admixtures may only be added to the grout used for filling sealed encapsulations, trumpets, and anchorage covers. Use admixtures compatible with the prestressing steels. Mix in accordance with the manufacturer's recommendations.

**643.02.02 Corrosion Protection.** (a) Tendon Bonded Length Protection. Provide a grout-filled corrugated plastic encapsulation for tendon bond length protection. For bars, the prestressing steel shall be grouted inside the encapsulation prior to inserting the tendon into the drill hole. Perform pregrouting of encapsulated tendons on an inclined, rigid frame or bed by injecting the grout from the low end of the tendon.

Fabricate tendon bonded length encapsulations from one of the following:

1. High density corrugated polyethylene tubing conforming to AASHTO M252 and having a minimum wall thickness of 1 mm (0.04 in.).

2. Corrugated PVC tubes conforming to ASTM D1784, Class 13464-B and having a minimum wall thickness of 1 mm (0.04 in.).

(b) Tendon Unbonded Length Protection. Provide corrosion protection of the unbonded length by a combination of sheaths, sheath filled with a corrosion inhibiting compound or grout, or a heat shrinkable tube internally coated with a mastic compound. The corrosion inhibiting compound shall completely coat the tendon elements, fill the void between them and the sheath, and fill the interstices between the wires of seven-wire strands. Make provisions to retain the compound within the sheath.

Extend the corrosion protection surrounding the unbonded length of the tendon 100 mm (4 in.) into the trumpet. The corrosion protection shall not come into contact with the stressing anchorage during testing. Trim off any excessive protection length.

Provide a separate bondbreaker or common sheath for supplemental corrosion protection or to prevent the tendon from bonding to the grout surrounding the unbonded length.

Fabricate the sheath from one of the following or approved equal:

1. Polyethylene tube pulled or pushed over the steel having a minimum wall thickness of 1.5 mm (1/16 in.) and conforming to ASTM D1248, Type II, III, or IV.

2. Hot-melt extruded polypropylene tube having a minimum wall thickness of 1.5 mm (1/16 in.) and conforming to ASTM D4101, Cell Classification B55542-11.

3. Hot-melt extruded polyethylene tube having a minimum wall thickness of 1.5 mm (1/16 in.) and conforming to ASTM D1248, Type III.

4. PVC pipe or tube, Schedule 40, conforming to ASTM D1784, Class 13464-B.

5. Corrugated PVC tubes conforming to ASTM D1784, Class 13464-B and having a minimum wall thickness of 1 mm (0.04 in.).

(c) Tendon Transition Protection. Design and fabricate the transition between the corrosion protection for the bonded and unbonded lengths using heat shrinkable sleeves of at least 150 mm (6 in.) length to ensure continuous protection from corrosive attack.

Manufacture heat shrinkable sleeves from radiation crosslinked polyolefin tube internally coated with an adhesive sealant. Prior to shrinking, the tube shall have a minimum wall thickness of 0.6 mm (0.024 in.). The adhesive sealant inside the heat shrinkable tube shall have a minimum thickness of 0.5 mm (0.020 in.).

(d) Coupler Protection. Cover the coupler and any adjacent exposed bar sections with a corrosion-proof compound or wax-impregnated cloth tape. The coupler area shall be covered by a smooth plastic tube complying with the requirements for tendon unbonded length protection, overlapping the adjacent sheathed tendon by at least 25 mm (1 in.). Seal the two joints with a coated heat shrinkable sleeve of at least 150 mm (6 in.) in length complying with the requirements for tendon transition protection. The corrosion-proof compound shall completely fill the space inside the cover tube.

If specifically permitted, submit corrosion protection details for strand couplers for approval.

(e) Anchorage Protection. Align the trumpet with the tendon. Provide a trumpet long enough to accommodate movements of the structure and the tendon during testing and stressing. On strand tendons, the trumpet shall be long enough to enable the tendon to make a transition from the diameter of the tendon along the unbonded length to the diameter of the tendon at the wedge plate without damaging the encapsulation.

The trumpet shall be completely filled with grout. Place grout after the ground anchor has been tested and stressed to the lock-off load. Trumpets shall have either a temporary seal between the trumpet and the unbonded length corrosion protection or the trumpet shall fit tightly over the unbonded length corrosion protection for a minimum of 100 mm (4 in.).

## CONSTRUCTION

**643.03.01 General.** Select the type of tendon to be used. Size the tendon so the design load does not exceed 60%, the maximum test load does not exceed 80%, and the lock-off load does not exceed 70% of the specified minimum tensile strength of the prestressing steel.

Determine the hole diameter and the bond length necessary to develop the design load specified on the plans. The minimum bond length shall be 4.5 m (15 ft) for strand tendons in rock and 3 m (10 ft) for bar tendons in rock. The minimum bond length shall be 4.5 m (15 ft) for strand and bar tendons in soil. The minimum unbonded length shall be as shown on the plans.

**643.03.02 Construction Site Survey**. Field locate and verify the location of all utilities prior to starting the work. Maintain uninterrupted service for those utilities designated to remain in service throughout the work. Give notification of any utility locations different from that shown that may require anchor relocations or wall design modification.

Prior to start of any wall construction activity, inspect the site to observe and document the pre-construction condition of the site, existing structures, and facilities. During construction, observe the conditions above the wall on a daily basis for signs of ground movement in the vicinity of the wall. Immediately give notification if signs of movements such as new cracks in structures, increased size of old cracks, or separation of joints in structures, foundations, streets, or paved and unpaved surfaces are observed.

**643.03.03 Excavation.** Coordinate the work and the excavation so the wall is safely constructed. Perform the wall construction and excavation sequence as shown and according to the approved submittals. Do not excavate above or below the wall steeper than shown on the plans without written approval.

Provide survey reference and control points at or offset along the top of wall alignment at approximate 10 m (30 ft) intervals prior to starting wall excavation. Be responsible for providing the necessary survey and alignment control during excavation of each lift, locating and drilling each drillhole within the allowable tolerances, and for performing the wall excavation and anchor installation in a manner which will allow for constructing the finish cast-in-place structural facing to the specified minimum thickness and to the line and grade as indicated.

Complete excavation and grading above and behind the wall before commencing wall excavation. Do not over-excavate the original ground behind the wall or at the ends of the wall, beyond the limits shown. Do not perform excavation that will affect the wall until wall construction starts.

Excavate to the final wall face using procedures that: prevent over excavation; prevent ground loss, swelling, air slaking, or loosening; prevent loss of support for completed portions of the wall; prevent loss of soil moisture at the face; and prevent ground freezing.

Give notification immediately if raveling or local instability of the final wall face excavation occurs. Temporarily stabilize unstable areas by means of buttressing the exposed face with an earth berm or other methods. Suspend work in unstable areas until remedial measures are developed.

If sections of the wall are to be constructed at different times, prevent sloughing or failure of the temporary slopes at the end of each wall section.

Remove all or portions of cobbles, boulders, rubble, or other subsurface obstructions encountered at the wall final excavation face which protrude into the wall facing. Determine the method of removal of face protrusions, including method to safely secure remnant pieces left behind the excavation face and for promptly backfilling voids resulting from removal of protrusions extending behind the excavation face. Backfill voids, overbreak, or over-excavation beyond the plan wall excavation line resulting from the removal of face protrusions or excavation operations.

**643.03.04 Drilling.** Select a drilling method to establish a stable hole of adequate dimensions within the tolerances specified. The drill bit or casing crown shall not be more than 3 mm (1/8 in.) smaller than the specified hole diameter. At the ground surface, locate the drill hole within 300 mm (12 in.) of the location shown.

Select drilling equipment and methods suitable for the ground conditions. If encountered, engineered fill may be non-cohesive and require casing during drilling operations. Cobbles and/or boulders may be encountered in the engineered fill. Use of drilling muds such as bentonite slurry to assist in drill cutting removal will not be allowed. Air may be used to assist in drill cutting removal. If caving ground is encountered, use cased drilling methods to support the sides of the drillholes. Remove casings prior to, or during, the grouting operation. When drilling through rock, cobbles, boulders, or obstructions, use percussion or other suitable drilling equipment capable of drilling and maintaining stable drillholes through such materials.

Clean holes to remove material resulting from the drilling operations and any other material that would impair the strength of the anchors. The use of water for cleaning holes will not be permitted. Do not install anchors in the drilled holes until the holes have been inspected and approval is given. Remove foreign material dislodged or drawn into the holes during construction of the assemblies.

Immediately suspend drilling operations if ground subsidence is observed, the wall is adversely affected, or adjacent structures are damaged from the drilling operation. Immediately stabilize the adverse conditions, make necessary repairs, and modify drilling operations prior to resuming drilling.

**643.03.05 Tendon Placement.** Place tendons as specified herein and as recommended by the manufacturer.

Inspect each anchor tendon before installation into the drill hole or casing. Repair damage to the corrosion protection system, or replace the tendon if not repairable. Reconnect loose spacers or centralizers to prevent shifting during insertion.

Check un-cased drill holes for cleanliness prior to insertion of the tendon.

Insert the tendon into the drill hole to the desired depth without difficulty and in a way that prevents damage to the drill hole, sheathing, coating, grout tubes, tendon, or corrosion protection. The bottom end of the tendon may be fitted with a cap or bullnose to aid its insertion into the hole, casing, or sheathing. Do not drive or force partially inserted tendons into the hole. Remove tendons which cannot be fully inserted to the required depth and clean the drill hole to allow unobstructed installation.

Do not extend anchors beyond the right-of-way or easement limits shown. Install anchors to plan location within the following tolerances:

| | |
|---|---|
| Anchor Head Location, deviation in any direction | 300 mm (12 in.) |
| Anchor Inclination | ± 3 degrees |
| Anchor Location, deviation from center of drill hole | 25 mm (1 in.) |

Replace anchors which do not satisfy the specified tolerances. Backfill abandoned drill holes with tremied grout.

**643.03.06 Grouting.** Use grout equipment which produces a uniformly mixed grout, free of lumps and undispersed cement, and capable of continuously agitating the mix. Use a positive displacement grout pump equipped with a pressure gauge which can measure at least twice but no more than three times the intended grout pressure. Size the grouting equipment to enable the entire anchor to be grouted in one continuous operation.

Inject the grout from the lowest point of the drill hole. The grout may be pumped through grout tubes, casing, hollow-stem-augers, or drill rods.

Place grout after insertion of the tendon.

Record the quantity of the grout and the grout pressures. Control the grout pressures and grout takes to prevent excessive heave or fracturing.

After the tendon is installed, the drill hole may be filled in one continuous grouting operation except that pressure grouting shall not be used in the free length zone. The grout at the top of the drill hole shall not contact the back of the structure or the bottom of the trumpet.

If the ground anchor is installed in a fine-grained soil using drill holes larger than 150 mm (6 in.) in diameter, place the grout above the top of the bond length after the ground anchor has been tested and stressed. If approved, grouting the entire drill hole at the same time may be allowed if it can be demonstrated that the ground anchor system does not derive a significant portion of its load carrying capacity from the soil above the bond length portion of the ground anchor.

Utilize pressure grouting techniques if grout protected tendons are used for ground anchors anchored in rock. Pressure grouting requires that the drill hole be sealed and that the grout be injected until a minimum 0.35 MPa (50 psi) grout pressure, measured at the top of the drill hole, can be maintained on the grout for at least 5 minutes.

The grout tube may remain upon completion of grouting if the tube is filled with grout.

**643.03.07 Anchorage Installation.** Install the anchor bearing plate and the anchor head or nut perpendicular to the tendon, within ± 3 degrees, and centered on the bearing plate without bending or kinking of the prestressing steel elements.

Wedge holes and wedges shall be free of rust, grout, and dirt.

Clean and protect the stressing tail from damage until final testing and lock-off.

After the anchor has been accepted, cut the stress tail to its final length according to the tendon manufacturer's recommendations. Perform cutting with an abrasive saw or other approved equipment.

**643.03.08 Stressing Equipment.** Use a dial gauge or vernier scale capable of measuring to the nearest 0.025 mm (0.001 in.) to measure the ground anchor movement. The measuring device shall have a minimum travel equal to the theoretical elastic elongation of the total anchor length at the maximum test load and shall have adequate travel so the ground anchor movement can be measured without resetting the device at an interim point.

Use a hydraulic jack and pump to apply the test load. Use the jack and a calibrated primary pressure gauge to measure the applied load. The jack and primary pressure gauge shall be calibrated as a unit within an accuracy of ± 2%. Have the calibration certificate and graph available on site at all times. The calibration shall be traceable to the National Institute of Standards and Technology or CALTRANS. The calibration shall have been performed within 60 days of the date when the calibration submittals are provided. Do not commence testing until the calibration has been approved.

The primary pressure gauge shall be graduated in 0.7 MPa (100 psi) increments or less. The stressing equipment shall be capable of measuring and maintaining the hydraulic pressure within 0.35 MPa (50 psi). The ram travel shall be at least 150 mm (6 in.). If elongations greater than 150 mm (6 in.) are required, restroking will be allowed.

Have a calibrated reference pressure gauge at the site to periodically check the production primary pressure gauge. The reference gauge shall be calibrated with the test jack and primary pressure gauge.

Provide an electrical resistance load cell and readout to be used when performing an extended creep test.

Place the stressing equipment over the ground anchor tendon in such a manner that the jack, bearing plates, load cells and stressing anchorage are axially aligned with the tendon and the tendon is centered within the equipment.

Select the stressing equipment and determine the sequence of stressing and the procedure to be used for each stressing operation at the planning stage of the project. Use the equipment in strict accordance with the manufacturer's operating instructions.

Provide stressing equipment capable of stressing the whole tendon in one stroke to the specified test load and stressing the tendon to the maximum specified test load within 75% of the rated capacity. Use a pump capable of applying each load increment in less than 60 seconds.

The equipment shall permit the tendon to be stressed in increments so that the load in the tendon can be raised or lowered in accordance with the test specifications and allow the anchor to be lift-off tested to confirm the lock-off load.

**643.03.09 Load Testing Setup.** Dial gauges shall bear on the pulling head of the jack and their stems shall be coaxial with the tendon direction. The gauges shall be supported on an independent, fixed frame, such as a tripod, which will not move as a result of stressing or other construction activities during the operation.

Prior to setting the dial gauges, accurately place the Alignment Load (AL) on the tendon. The magnitude of the AL depends on the type and length of the tendon.

Avoid regripping of strands, which would cause overlapping wedge bites or wedge bites on the tendon below the anchor head.

Stressing and testing of multiple element tendons with single element jacks will not be permitted.

Do not begin stressing before the grout has cured for a minimum of 3 days and has reached a minimum compressive strength of 21 MPa (3,000 psi).

**643.03.10 Performance Tests.** Conduct performance tests on the ground anchors designated on the plans in accordance with the procedures described below.

Conduct all performance tests prior to proof tests. Proof test the remaining ground anchors in accordance with Subsection 643.03.11.

Do not apply a load greater than 10% of the design load to the ground anchor prior to testing. Apply the test load simultaneously to the entire tendon. Stressing of single elements of multi-element tendons will not be permitted.

Conduct the performance test by incrementally loading and unloading the ground anchor in accordance with the schedule below.

Raise the load from one increment to another immediately after recording the ground anchor movement. Measure and record the ground anchor movement to the nearest 0.025 mm (0.001 in.) with respect to an independent fixed reference point at the alignment load and at each increment of load.

Monitor the load with the primary pressure gauge. Place the reference pressure gauge in series with the primary gauge during each performance test. If the load determined by the reference pressure gauge and the load determined by the primary pressure gauge differ by more than 10%, recalibrate the jack, primary pressure gauge, and reference pressure gauge.

At load increments other than the maximum test load, hold the load just long enough to obtain the movement reading.

Hold the maximum test load in a performance test for 10 minutes. Use a load cell to monitor small changes in load during constant load-hold periods.

**Performance Test Schedule**

| Step | Loading | Applied Load | Record and Plot Total Movement, $\delta_{ti}$ | Record and Plot Residual Movement, $\delta_{ri}$ | Calculate Elastic Movement, $\delta_{ei}$ |
|---|---|---|---|---|---|
| 1 | | AL | | | |
| 2 | Cycle 1 | 0.25DL | $\delta_{t1}$ | | |
| | | AL | | $\delta_{r1}$ | $\delta_{t1} - \delta_{r1} = \delta_{e1}$ |
| 3 | Cycle 2 | 0.25DL | $\delta_2$ | | |
| | | 0.50DL | $\delta_{t2}$ | | |
| | | AL | | $\delta_{r2}$ | $\delta_{t2} - \delta_{r2} = \delta_{e2}$ |
| 4 | Cycle 3 | 0.25DL | $\delta_3$ | | |
| | | 0.50DL | $\delta_3$ | | |
| | | 0.75DL | $\delta_{t3}$ | | |
| | | AL | | $\delta_{r3}$ | $\delta_{t3} - \delta_{r3} = \delta_{e3}$ |
| 5 | Cycle 4 | 0.25DL | $\delta_4$ | | |
| | | 0.50DL | $\delta_4$ | | |
| | | 0.75DL | $\delta_4$ | | |
| | | 1.00DL | $\delta_{t4}$ | | |
| | | AL | | $\delta_{r4}$ | $\delta_{t4} - \delta_{r4} = \delta_{e4}$ |
| 6 | Cycle 5 | 0.25DL | $\delta_5$ | | |
| | | 0.50DL | $\delta_5$ | | |
| | | 0.75DL | $\delta_5$ | | |
| | | 1.00DL | $\delta_5$ | | |
| | | 1.2DL | $\delta_{t5}$ | | |
| | | AL | | $\delta_{r5}$ | $\delta_{t5} - \delta_{r5} = \delta_{e5}$ |
| 7 | Cycle 6 | 0.25DL | $\delta_6$ | | |
| | | 0.50DL | $\delta_6$ | | |
| | | 0.75DL | $\delta_6$ | | |
| | | 1.00DL | $\delta_6$ | | |
| | | 1.2DL | $\delta_6$ | | |
| | | 1.33DL | $\delta_{t6}$ * | | |
| | | AL | | $\delta_{r6}$ | $\delta_{t6} - \delta_{r6} = \delta_{e6}$ |

* Zero reading for creep test. Hold load for 10 minutes while recording movement at specified times. If the total movement measured during the load hold exceeds the specified maximum value then the load hold shall be extended to a total of 60 minutes.

AL = Alignment Load, DL = Design Load, $\delta_i$ = Total movement at a load other than the maximum for cycle i, $_i$ = Number identifying a specific load cycle.

Adjust the jack as necessary in order to maintain a constant load. Start the load-hold period as soon as the maximum test load is applied and measure and record the ground anchor movement, with respect to a fixed reference at 1, 2, 3, 4, 5, 6, and 10 minutes. If the ground anchor movement between 1 minute and 10 minutes exceeds 1 mm (0.04 in.), hold the maximum test load for an additional 50 minutes. If the load hold is extended, record the ground anchor movement at 15, 20, 30, 40, 50, and 60 minutes.

**643.03.11 Proof Tests.** Proof test each ground anchor. Do not apply a load greater than 10% of the design load to the ground anchor prior to testing. Apply the test load simultaneously to the entire tendon. Stressing of single elements of multi-element tendons will not be permitted.

Perform the proof test by incrementally loading the ground anchor in accordance with the schedule below. Raise the load from one increment to another immediately after recording the ground anchor movement. Measure and record the ground anchor movement to the nearest 0.025 mm (0.001 in.) with respect to an independent fixed reference point at the alignment load and at each increment of load. Monitor the load with the primary pressure gauge. At load increments other than the maximum test load, hold the load just long enough to obtain the movement reading.

**Proof Test Schedule**

| Step | Load |
|---|---|
| 1 | AL |
| 2 | 0.25DL |
| 3 | 1.50DL |
| 4 | 0.75DL |
| 5 | 1.00DL |
| 6 | 1.20DL |
| 7 | 1.33DL |
| 8 | Reduce to lock-off load |
| 9 | AL (optional) |
| 10 | Adjust to lock-off load |

Hold the maximum test load in a proof test for 10 minutes. Adjust the jack as necessary in order to maintain a constant load. Start the load-hold period as soon as the maximum test load is applied and measure and record the ground anchor movement with respect to a fixed reference at 1, 2, 3, 4, 5, 6, and 10 minutes. If the ground anchor movement between 1 minute and 10 minutes exceeds 1 mm (0.04 in.), hold the maximum test load for an additional 50 minutes. If the load hold is extended, record the ground anchor movements at 15, 20, 30, 40, 50, and 60 minutes.

**643.03.12 Extended Creep Tests.** The ground anchors to be creep tested will be selected.

Conduct the extended creep test by incrementally loading and unloading the ground anchor in accordance with step 7 of the performance test schedule in Subsection 643.03.10. At the end of each load increment, hold the load constant for the observation period indicated in the schedule below. The times for reading and recording the ground anchor movement during each observation period shall be 1, 2, 3, 4, 5, 6, 10, 15, 20, 25, 30, 45, 60, 75, 90, 100, 120, 150, 180, 210, 240, 270, and 300 minutes as appropriate for the load increment. Start each load-hold period as soon as the test load is applied. In an extended creep test, use the primary pressure gauge and reference pressure gauge to measure the applied load and use the load cell to monitor small changes in load during constant load-hold periods. Adjust the jack as necessary in order to maintain a constant load.

Plot the ground anchor movement and the residual movement measured in an extended creep test. Plot also the creep movement for each load hold as a function of the logarithm of time.

**Extended Creep Test Schedule**

| Load | Observation Period, Minutes |
|---|---|
| AL | --- |
| 0.25DL | 10 |
| 0.50DL | 30 |
| 0.75DL | 30 |
| 1.00DL | 45 |
| 1.20DL | 60 |
| 1.33DL | 300 |

**643.03.13 Ground Anchor Acceptance.** A performance tested or proof tested ground anchor with a 10 minute load hold will be considered acceptable if the ground anchor resists the maximum test load with less than 1 mm (0.04 in.) of movement between 1 minute and 10 minutes and the total elastic movement at the maximum test load exceeds 80% of the theoretical elastic elongation of the unbonded length.

A performance tested or proof tested ground anchor with a 60 minute load hold will be considered acceptable if the ground anchor resists the maximum test load with a creep rate that does not exceed 2 mm (0.08 in.) in the last log cycle of time (between the reading at 6 and 60 minutes) and the total elastic movement at the maximum test load exceeds 80% of the theoretical elastic elongation of the unbonded length.

A ground anchor subjected to extended creep testing will be considered acceptable if the ground anchor resists the maximum test load with a creep rate that does not exceed 2 mm (0.08 in.) in the last log cycle of time (between the reading at 30 and 300 minutes) and the total elastic movement at the maximum test load exceeds 80% of the theoretical elastic elongation of the unbonded length.

The maximum acceptable test load with respect to creep shall correspond to that where acceptable creep movements are measured over the final log cycle of time.

The initial lift-off reading shall be within ± 5% of the designed lock-off load. If this requirement is not met, adjust the tendon load accordingly and repeat the initial lift-off reading.

Anchors that do not satisfy the minimum apparent free length criteria shall be either rejected and replaced or locked off at not more than 50% of the maximum acceptable load attained. Submit proposed procedures for obtaining the required remaining load.

Regroutable anchors which satisfy the minimum apparent free length criteria but which fail the extended creep test at the test load may be postgrouted and subjected to an enhanced creep criterion. This enhanced criterion requires a creep movement of not more than 1 mm (0.04 in.) between 1 and 60 minutes at test load. Anchors which satisfy the enhanced creep criterion shall be locked off at the design lock-off load. Anchors which cannot be postgrouted or regroutable anchors that do not satisfy the enhanced creep criterion shall be either rejected or locked off at 50% of the maximum acceptable test load attained. Submit proposed procedures for obtaining the required remaining load.

In the event that an anchor fails, modify the design and/or construction procedures. The modifications may include, but are not limited to, installing additional anchors, changing the installation methods, reducing the anchor design load by increasing the number of anchors, increasing the anchor length, changing the anchor type, or post-grouting. Submit a description of any proposed modifications for review and approval. Do not implement proposed modifications until receiving written approval.

**643.03.14 Anchor Lock-Off.** The magnitude of the lock-off load will be specified on the plans. After testing has been completed, the load in the tendon shall be such that after seating losses, the specified lock-off load has been applied to the anchor tendon.

For single or multiple elements of prestressing strands, seat the wedges at a minimum load of 50% $F_{pu}$. If the lock-off load is less than 50% $F_{pu}$, use shims under the wedge plate and seat the wedges at 50% $F_{pu}$. Remove the shims under the wedge plate to reduce the load in the tendon to the desired lock-off load.

After transferring the load to the anchorage, and prior to removing the jack, conduct a lift-off test to confirm the magnitude of the load in the anchor tendon. This load is determined by reapplying load to the tendon to lift off the wedge plate, or anchor nut, without unseating the wedges, or turning the anchor nut.

## METHOD OF MEASUREMENT

**643.04.01 Measurement.** Ground anchors, performance tests, and extended creep tests will be measured by the each.

## BASIS OF PAYMENT

**643.05.01 Payment.** The accepted quantities, measured as provided above, will be paid for at the contract price per unit of measurement for the pay items listed below that are shown in the proposal. Payment will be full compensation for the work prescribed in this Section.

Payment will be made under:

| Pay Item | Pay Unit |
|---|---|
| Ground Anchor | Each |
| Performance Test | Each |
| Extended Creep Test | Each |

# SECTION 644

## SOIL NAIL RETAINING WALLS

DESCRIPTION

**644.01.01 General.** This work consists of constructing soil nail retaining walls. Perform soil nail construction concurrently with pneumatically placed concrete mortar as specified in Section 660.

**644.01.02 Qualifications.** Prepare a project reference list verifying the successful construction completion of at least 4 permanent soil nail retaining wall projects during the past 2 years totaling at least 1,000 $m^2$ (1,200 $yd^2$) of wall face area and at least 500 permanent soil nails. Include a brief description of each project with the Owner's name and current phone number.

Provide a Nevada Registered Professional Engineer, employed by the soil nailing Contractor and having experience in the construction of permanent soil nail retaining walls on at least 4 completed projects over the past 2 years, to supervise the work. Consultants or manufacturer's representatives will not be allowed to satisfy the aforementioned requirement. Use an on-site supervisor and drill rig operators having experience installing permanent soil nails on at least 4 projects over the past 2 years. Prepare a personnel qualifications list containing a summary of each individual’s experience and the respective projects.

**644.01.03 Submittals.** Submit 5 copies of the following information for review and approval at least 30 days prior to beginning wall construction:

1. Project reference list and personnel qualifications list.

2. Proposed start date and detailed wall construction sequence.

3. Plan describing diversion, control, and disposal of surface water.

4. Proposed methods and equipment for excavating the soil and/or rock to the staged excavation lifts indicated, including the proposed grade elevations for each excavation lift shown on a wall elevation view.

5. Measures to ensure wall and slope stability during various stages of wall construction and excavation where discontinuous rows of nails are installed.

6. If applicable, description of space requirements for installation equipment, temporary shoring plans, and provisions for working in the proximity of underground facilities or utilities.

7. Proposed nail drilling methods and equipment including drillhole diameter proposed to achieve the specified pullout resistance values and any variation of these along the wall alignment.

8. Nail grout mix design including type and source of cement, aggregate source and gradation, proportions of mix by weight and water-cement ratio, and brand name and technical literature for proposed admixtures. Furnish test results supplied by a qualified independent testing lab, verifying the specified minimum 3 day and 28 day compressive strengths. Previous test results for the proposed grout mix completed within one year of the start of grouting may be submitted for review and approval.

9. Proposed nail grout placement procedures and equipment.

10. Proposed nail testing methods and equipment setup including: details of the jacking frame and appurtenant bracing, details showing methods of isolating test nails during shotcrete application, details showing methods of providing the temporary unbonded length and of grouting the temporary unbonded length of test nails after completion of testing, and equipment list.

11. Identification number and certified calibration records for each test jack and pressure gauge and load cell to be used. Jack and pressure gauge must be calibrated as a unit. Calibration records shall include the date tested, device identification number, and the calibration test results and shall be certified for an accuracy of at least 2% of the applied certification loads by a qualified independent testing laboratory within 90 days prior to submittal.

12. Manufacturer Certificates of Compliance for the soil nail centralizers or encapsulation.

Approval or rejection of the submittals will be given within 20 days after receipt of a complete submission. Do not begin wall construction or incorporate materials into the work until the submittal requirements are satisfied and found acceptable. Changes or deviations from the approved submittals shall be re-submitted for approval. No adjustments in contract time will be allowed due to incomplete submittals.

Upon delivery of nail bars to the project site, provide certified mill test results for nail bars and couplers from each heat specifying the ultimate strength, yield strength, elongation, and composition.

Furnish all records documenting the soil nail wall construction. Provide as-built drawings showing final nail locations and final shotcrete facing line and grade within 5 days after completion of the shotcrete facing.

## MATERIALS

**644.02.01 General.** Materials shall conform to the following Sections and Subsections:

| | |
|---|---|
| Water | Section 722 |
| Grout and Mortar Aggregate | Subsection 706.03.04 |
| Portland Cement | Section 701 |
| Concrete Curing Materials and Admixtures | Section 702 |

Soil nail bars shall be solid bars and shall conform to ASTM A706 or ASTM A615, Grade 420 (60) or 520 (75), or ASTM A722 Grade 1035 (150). Furnish deformed bars that are continuous without splices or welds. Bars shall be encapsulated when shown on the plans. Thread bars a minimum of 150 mm (6 in.) on the wall anchorage end to allow proper attachment of bearing plate and nut. Threading may be continuous spiral deformed ribbing provided by the bar deformations or may be cut into a reinforcing bar. If threads are cut into a reinforcing bar, provide the next larger bar number designation from that shown.

Encapsulation shall be a minimum 1 mm (0.04 in.) thick corrugated HDPE tube conforming to AASHTO M252 or corrugated PVC tube conforming to ASTM D1784, Class 13464-B. Encapsulation shall provide at least 5 mm (0.20 in.) of grout cover over the nail bar and be resistant to ultra violet light degradation, normal handling stresses, and grouting pressures.

Centralizers shall be manufactured from Schedule 40 PVC pipe or tube, steel, or other material not detrimental to the nail steel. Wood centralizers will not be allowed. Securely attach centralizers to the nail bar. Size centralizers to position the nail bar within 25 mm (1 in.) of the center of the drillhole, allow tremie pipe insertion to the bottom of the drillhole, and allow grout to freely flow up the drillhole.

Grout shall be neat cement or aggregate/cement mixture with a minimum 3 day compressive strength of 10.5 MPa (1,500 psi) and a minimum 28 day compressive strength of 21 MPa (3,000 psi). Perform compressive strength testing according to AASHTO T106/ASTM C109.

Admixtures which control bleed, improve flowability, reduce water content, and retard set may be used in the grout subject to review and approval. Accelerators will not be permitted. Expansive admixtures may only be used in grout used for filling sealed encapsulations. Use admixtures which are compatible with the grout. Mix according to the manufacturer's recommendations.

## CONSTRUCTION

**644.03.01 General.** Build soil nail walls from the top down in existing ground. Soil nailing includes excavating in accordance with the staged lifts shown in the plans or approved submittals, drilling soil nail drillholes to the specified minimum length and orientation, placing and grouting the encapsulated nail bar tendons into the drillholes, attaching bearing plates and nuts, and performing nail testing.

The placing of drainage elements, shotcrete reinforcement, and shotcrete facing as provided for in Section 660 shall be performed concurrently with the work specified herein.

A mandatory pre-construction meeting will be scheduled and held prior to the start of wall construction. The Contractor, Engineer, and all personnel responsible for supervising work related to surveying, excavation, installing soil nails, grouting, testing, and shotcreting shall attend the meeting. The pre-construction meeting will be conducted to clarify the construction requirements for the work, to coordinate the construction schedule and activities, and to identify contractual relationships and delineation of responsibilities amongst the Contractor and the various Subcontractors, particularly those pertaining to wall excavation, nail installation and testing, excavation and wall alignment survey control, and shotcrete construction.

**644.03.02 Construction Site Survey.** Field locate and verify the location of all utilities prior to starting the work. Maintain uninterrupted service for those utilities designated to remain in service throughout the work. Give notification of any utility locations different from that shown that may require nail relocations or wall design modification.

Prior to start of any wall construction activity, inspect the site to observe and document the pre-construction condition of the site, existing structures, and facilities. During construction, observe the conditions above the soil nail wall on a daily basis for signs of ground movement in the vicinity of the wall. Immediately give notification if signs of movements such as new cracks in structures, increased size of old cracks, or separation of joints in structures, foundations, streets, or paved and unpaved surfaces are observed.

**644.03.03 Control of Water.** Provide positive control and discharge of all surface water that will affect construction of the soil nail retaining wall. Maintain all pipes or conduits used to control surface water and repair damage caused by surface water during construction. Upon substantial completion of the wall, remove surface water control pipes or conduits from the site. If approved, pipes or conduits may be left in place, provided they are fully grouted and abandoned or left in a way that protects the structure and all adjacent facilities from migration of fines through the pipe or conduit and potential ground loss.

Localized areas of perched water or seepage may be encountered during excavation. See the geotechnical report for regional groundwater table.

Immediately give notification if unanticipated existing subsurface drainage structures are discovered during excavation. Suspend work in these areas until remedial measures, as approved, are implemented. Capture surface water runoff flows independently of the wall drainage network and convey them as directed.

**644.03.04 Excavation.** Coordinate the work and the excavation so the wall is safely constructed. Perform the wall construction and excavation sequence as shown and according to the approved submittals. Do not excavate above or below the soil nail wall steeper than specified herein or shown on the plans without written approval.

Provide survey reference and control points at or offset along the top of wall alignment at approximate 10 m (30 ft) intervals prior to starting wall excavation. Be responsible for providing the necessary survey and alignment control during excavation of each lift, locating and drilling each drillhole within the allowable tolerances, and for performing the wall excavation and nail installation in a manner which will allow for constructing the shotcrete construction facing to the specified minimum thickness and such that the finish cast-in-place structural facing can be constructed to the specified minimum thickness and to the line and grade as indicated. Where the completed location of the front face of the shotcrete exceeds the allowable tolerance from the wall control line as shown, submit procedure to provide proper attachment of nail head bearing plate connections and satisfactory placement of the final facing for review and approval.

Complete excavation and grading above and behind the wall before commencing wall excavation. Do not over-excavate the original ground behind the wall or at the ends of the wall, beyond the limits shown. Do not perform excavation that will affect the soil nail wall until wall construction starts.

Coordinate roadway excavation with the soil nailing work. Perform excavation from the top down in a horizontal staged excavation lift sequence with the ground level for each lift excavated no more than mid-height between adjacent nail rows or the short-term stand-up height of the ground, whichever is less. Do not excavate the full wall height to the final wall alignment. Maintain a working bench of native material to serve as a platform for the drilling equipment. Construct the bench wide enough to provide a safe working area for the drill equipment and workers.

Excavate to the final wall face using procedures that: prevent over excavation; prevent ground loss, swelling, air slaking, or loosening; prevent loss of support for completed portions of the wall; prevent loss of soil moisture at the face; and prevent ground freezing. Complete excavation to the final wall excavation line and apply shotcrete in the same work shift, unless otherwise approved. Application of the shotcrete may be delayed up to 24 hours if the delays will not adversely affect the excavation face stability.

During each excavation lift, nails may be drilled and installed through a temporary stabilizing berm. Do not excavate the stabilizing berm until the nail grout has aged for at least 24 hours. Excavate the temporary stabilizing berm to the final wall face excavation line and clean the final excavation face of all loose materials, mud, rebound, and other foreign matter which could prevent or reduce shotcrete bond. Ensure that installed nails and corrosion protection are not damaged during excavation of the stabilizing berm. Repair or replace nails or corrosion protection damaged or disturbed during excavation of the stabilizing berm, as approved.

Remove hardened nail grout protruding more than 50 mm (2 in.) from the final wall excavation line in a manner that prevents fracturing the grout at the nail head. Sledge hammer removal of the grout will not be allowed. The use of hand held rock chippers will be acceptable provided their use does not damage or disturb the remaining grout at the nail head, the nail bar, or corrosion protection. Submit alternative excavation and soil nail installation methods that meet these objectives for review and approval.

Do not excavate the next lift until nail installation, shotcrete placement, attachment of bearing plates and nuts, and nail testing has been completed and accepted in the current lift. Cure nail grout and shotcrete for at least 72 hours or until they have attained at least their specified 3 day compressive strength before excavating the following underlying lift. Excavation of the following lift in less than 72 hours will only be allowed if submitted compressive strength test results, for tests performed by a qualified independent testing lab, verify that the nail grout and shotcrete mixes being used will provide the specified 3 day compressive strengths in the lesser time.

Give notification immediately if raveling or local instability of the final wall face excavation occurs. Temporarily stabilize unstable areas by means of buttressing the exposed face with an earth berm or other methods. Suspend work in unstable areas until remedial measures are developed.

If sections of the wall are to be constructed at different times, prevent sloughing or failure of the temporary slopes at the end of each wall section.

Remove all or portions of cobbles, boulders, rubble, or other subsurface obstructions encountered at the wall final excavation face which protrude into the shotcrete facing. Determine the method of removal of face protrusions, including method to safely secure remnant pieces left behind the excavation face and for promptly backfilling voids resulting from removal of protrusions extending behind the excavation face. Backfill voids, overbreak, or over-excavation beyond the plan wall excavation line resulting from the removal of face protrusions or excavation operations.

**644.03.05 Drilling.** Determine the final drillhole diameters required to develop the specified pullout resistance and to also provide a minimum 25 mm (1 in.) grout cover over bare bars or minimum 13 mm (1/2 in.) grout cover over the encapsulation of encapsulated nails. A minimum drillhole diameter will be shown on the plans.

Do not begin drilling or installation of production nails in any soil/rock unit until successful pre-production verification testing of nails is completed in that unit.

Install the production soil nails before the application of the reinforced shotcrete facing. The shotcrete facing may be placed before drilling and installing the nails subject to written approval. Provide a blockout through the shotcrete facing at drillhole locations using PVC pipe or other suitable material to prevent damage to the facing during drilling. As part of the required construction submittals, provide structural design calculations demonstrating that the facing structural capacity will not be reduced and that the bearing plates are adequate to span the nail drillhole blockout. If required, furnish larger size bearing plates and/or additional reinforcement beyond that detailed.

Select drilling equipment and methods suitable for the ground conditions. If encountered, engineered fill may be non-cohesive and require casing during drilling operations. Cobbles and/or boulders may be encountered in the engineered fill. Use of drilling muds such as bentonite slurry to assist in drill cutting removal will not be allowed. Air may be used to assist in drill cutting removal. If caving ground is encountered, use cased drilling methods to support the sides of the drillholes. Remove casings prior to, or during, the grouting operation. When drilling through rock, cobbles, boulders, or obstructions, use percussion or other suitable drilling equipment capable of drilling and maintaining stable drillholes through such materials.

Clean holes to remove material resulting from the drilling operations and any other material that would impair the strength of the soil nails or test soil nails. The use of water for cleaning holes will not be permitted. Do not install nails in the drilled holes until the holes have been inspected and approval is given. Remove foreign material dislodged or drawn into the holes during construction of the assemblies.

Immediately suspend drilling operations if ground subsidence is observed, the soil nail wall is adversely affected, or adjacent structures are damaged from the drilling operation. Immediately stabilize the adverse conditions, make necessary repairs, and modify drilling operations prior to resuming drilling.

**644.03.06 Nail Placement.** Provide nail bars in accordance with the schedules shown. Position centralizers as shown so their maximum center-to-center spacing does not exceed 3 m (10 ft). Locate centralizers within 0.6 m (2 ft) from the top and bottom of the drillhole.

Inspect each nail bar before installation and repair or replace damaged bars or corrosion protection. Check uncased drillholes for cleanliness prior to insertion of the soil nail bar. Insert nail bars with centralizers into the drill hole to the required length without difficulty and in a way that prevents damage to the drillhole, bar, or corrosion protection. Do not drive or force partially inserted soil nails into the hole. Remove nails which cannot be fully inserted to the design depth and clean the drill hole to allow unobstructed installation.

Do not extend nails beyond the right-of-way or easement limits shown. Install soil nails to plan location within the following tolerances:

Nail Head Location, deviation in any direction ..... 150 mm (6 in.)
Nail Inclination ..... ± 3 degrees
Nail Location, deviation from center of drillhole ..... 25 mm (1 in.)

Location tolerances are applicable to only one nail and not accumulative over large wall areas.

Replace soil nails which do not satisfy the specified tolerances. Backfill abandoned nail drill holes with tremied grout.

**644.03.07 Grouting.** Use grout equipment which produces a uniformly mixed grout, free of lumps and undispersed cement, and capable of continuously agitating the mix. Use a positive displacement grout pump equipped with a pressure gauge which can measure at least twice but no more than three times the intended grout pressure. Size the grouting equipment to enable the entire nail to be grouted in one continuous operation.

Place the grout within 60 minutes after mixing or within the time recommended by the admixture manufacturer, if admixtures are used. Grout not placed in the allowed time limit will be rejected.

Place nails and grout within 2 hours of completion of drilling, unless otherwise approved. Inject the grout at the lowest point of each drillhole through a grout tube, casing, hollow-stem auger, or drill rods. Keep the outlet end of the conduit delivering the grout below the surface of the grout as the conduit is withdrawn to prevent the creation of voids. Completely fill the drillhole in one continuous operation. Cold joints in the grout column will not be allowed except at the top of the test bond length of proof tested production nails. The grout tube may remain in the hole provided it is filled with grout. Grouting before insertion of the nail will be allowed provided the nail bar is immediately inserted through the grout to the specified length without difficulty.

During casing removal for drillholes advanced by either cased or hollow-stem auger methods, maintain sufficient grout level within the casing to offset the external groundwater/soil pressure and prevent hole caving. Maintain grout head or grout pressures sufficient to ensure that the drillhole will be completely filled with grout and to prevent unstable soil or groundwater from contaminating or diluting the grout. Record the grout pressures for soil nails installed using pressure grouting techniques. Control grout pressures to prevent excessive ground heave or fracturing.

Remove the grout and nail if grouting is suspended for more than 30 minutes or does not satisfy the requirements specified herein. Submit corrective procedures for review and approval.

**644.03.08 Verification Testing.** Perform pre-production verification testing prior to installation of production nails to verify installation methods and nail pullout resistance. Verification test nails are sacrificial and are not incorporated as production nails. Bare bars may be used for the sacrificial verification test nails.

Furnish necessary testing equipment including dial gauges, dial gauge support, jack and pressure gauge, electronic load cell, and a reaction frame. The load cell is required only for creep test portion of verification test.

Test nails shall have both bonded and temporary unbonded lengths. Prior to testing, grout only the bonded length of the test nail. The temporary unbonded length of the test nail shall be a minimum of 1 m (3 ft). Determine the maximum bonded length of test nail by the following equation:

$$L_{BV} = C\, f_Y\, A_S / 2\, Q_d$$

Where:
$L_{BV}$ = Maximum Verification Test Nail Bonded Length, m (ft)
$C$ = 0.9 for Grade 420 (60) and 520 (75) bars and 0.8 for Grade 1035 (150) bars
$f_Y$ = Bar Yield or Ultimate Stress, kN/m$^2$ (ksi)
$A_S$ = Bar Steel Area, m$^2$ (in$^2$)
$Q_d$ = Allowable Pullout Resistance, kN/m (kips/ft)

The actual bonded test length constructed for testing shall be greater than 3 m (10 ft) but less than the maximum bonded length, $L_{BV}$, as calculated above.

Determine the Design Verification Load by the following equation:

$$DVL = L_{BA} \times Q_d$$

Where: DVL = Design Verification Load, kN (kips)
$L_{BA}$ = Actual Test Nail Bonded Length, m (ft)
$Q_d$ = Allowable Pullout Resistance, kN/m (kips/ft)

Construct verification test nails using the same equipment, installation methods, nail inclination, and drillhole diameter as planned for the production nails. Changes in the drilling or installation method may require additional verification testing as determined.

Verification test nails may be installed through either the existing slope face prior to start of wall excavation, drill platform work bench, stabilization berm or into slot cuts made for the particular lift in which the verification test nails are located. Slot cuts shall only be large enough to safely accommodate the drill and test nail reaction setup. Subject to approval, verification test nails may also be installed at angle orientations other than perpendicular to the wall face or at different locations than specified, as long as it can be demonstrated that the test nails will be bonded into ground which is representative of the ground at the designated verification test nail locations.

Do not perform nail testing until the nail grout and shotcrete facing have cured for at least 72 hours and attained at least their specified 3 day compressive strength. If approved, testing in less than 72 hours may be allowed if submitted compressive strength test results verify that the nail grout and shotcrete mixes being used obtain the specified 3 day compressive strengths in the lesser time.

Design the testing reaction frame to be sufficiently rigid and of adequate dimensions such that excessive deformation of the testing equipment does not occur. If the reaction frame bears directly on the shotcrete facing, design it to prevent cracking of the shotcrete. Independently support and center the jack over the nail bar so that the bar does not carry the weight of the testing equipment. Align the jack, bearing plates, and stressing anchorage with the bar such that unloading and repositioning of the equipment is not required during the test.

Isolate the test nail bar from the shotcrete facing and/or the reaction frame used during testing. Isolation of a test nail through the shotcrete facing shall not affect the location of the reinforcing steel under the bearing plate. Where temporary casing of the unbonded length of test nails is provided, install the casing in a way that prevents any reaction between the casing and the grouted bond length of the nail and/or the stressing apparatus.

Apply and measure the test load with a hydraulic jack and pressure gauge. Graduate the pressure gauge in 0.7 MPa (100 psi) increments or less. The jack and pressure gauge shall have a pressure range not exceeding twice the anticipated maximum test pressure. Jack ram travel shall be sufficient to allow the test to be done without resetting the equipment. Monitor the nail load during testing with both the pressure gauge and the load cell. Use the load cell to maintain constant load hold during the creep test load hold increment.

Measure the nail head movement with a dial gauge capable of measuring to 0.025 mm (0.001 in.). Use a dial gauge with sufficient travel to allow the test to be done without having to reset the gauge. Visually align the gauge to be parallel with the axis of the nail and support the gauge independently from the jack, wall, or reaction frame. Use two dial gauges when the test setup requires reaction against a soil cut face.

Incrementally load verification test nails according to the schedule below. Record the soil nail movements at each load increment.

**Verification Test Loading Schedule**

| Load | Hold Time, Minutes |
|---|---|
| Alignment | 1 |
| 0.25 DVL | 10 |
| 0.50 DVL | 10 |
| 0.75 DVL | 10 |
| 1.00 DVL | 10 |
| 1.25 DVL | 10 |
| Creep Test | 60 |
| 1.75 DVL | 10 |
| 2.00 DVL | 10 |

The Alignment Load shall be the minimum load required to align the testing apparatus and shall not exceed 0.05 DVL. Set dial gauges to "zero" after the alignment load has been applied.

Monitor the verification test nail for creep at the 1.50 DVL load increment. Measure and record nail movements during the creep portion of the test at 1, 2, 3, 5, 6, 10, 20, 30, 50, and 60 minutes. Maintain the load during the creep test within 2% of the intended load by use of the load cell.

A test nail will be considered acceptable when:

1. A total creep movement of less than 2 mm (0.08 in.) per log cycle of time between the 6 and 60 minute readings is measured during creep testing and the creep rate is linear or decreasing throughout the creep test load hold period.

2. The total measured movement at the maximum test load exceeds 80%of the theoretical elastic elongation of the test nail unbonded length.

3. A pullout failure does not occur at the maximum test load of 2.00 DVL. Pullout failure is defined as the load at which attempts to further increase the test load simply result in continued pullout movement of the test nail. Record the pullout failure load as part of the test data.

If a test nail does not satisfy the acceptance criterion, determine the cause.

Installation methods which do not satisfy the nail testing requirements will not be allowed. Propose alternative methods and install and test replacement verification test nails.

**644.03.09 Proof Testing.** Perform proof testing on 5% of the production nails in each nail row with a minimum of 1 per row. The nails to be tested will be designated.

Furnish necessary testing equipment including dial gauges, dial gauge support, jack and pressure gauge, and a reaction frame.

Provide production proof test nails having both bonded and temporary unbonded lengths. Prior to testing, grout only the bonded length of the test nail. The temporary unbonded length of the test nail shall be a minimum of 1 m (3 ft). Determine the maximum bonded length of test nail by the following equation:

$$L_{BP} = C\, f_Y\, A_S / 1.5\, Q_d$$

Where:
- $L_{BP}$ = Maximum Proof Test Nail Bonded Length, m (ft)
- $C$ = 0.9 for Grade 420 (60) and 520 (75) bars and 0.8 for Grade 1035 (150) bars
- $f_Y$ = Bar Yield or Ultimate Stress, kN/m$^2$ (ksi)
- $A_S$ = Bar Steel Area, m$^2$ (ft$^2$)
- $Q_d$ = Allowable Pullout Resistance, kN/m (kips/ft)

The actual bonded test length constructed for testing shall be greater than 3 m (10 ft) but less than the maximum bonded length, $L_{BP}$, as calculated above.

Determine the Design Proof Load by the following equation:

$$DPL = L_{BA} \times Q_d$$

Where:
- DPL = Design Proof Load, kN (kips)
- $L_{BA}$ = Actual Test Nail Bonded Length, m (ft)
- $Q_d$ = Allowable Pullout Resistance, kN/m (kips/ft)

Do not perform testing until the nail grout and shotcrete facing have cured for at least 72 hours and attained at least their specified 3 day compressive strength. If approved, testing in less than 72 hours may be allowed if submitted compressive strength test results verify that the nail grout and shotcrete mixes being used obtain the specified 3 day compressive strengths in the lesser time.

Design the testing reaction frame to be sufficiently rigid and of adequate dimensions such that excessive deformation of the testing equipment does not occur. If the reaction frame bears directly on the shotcrete facing, design it to prevent cracking of the shotcrete. Independently support and center the jack over the nail bar so that the bar does not carry the weight of the testing equipment. Align the jack, bearing plates, and stressing anchorage with the bar such that unloading and repositioning of the equipment is not required during the test.

Isolate the test nail bar from the shotcrete facing and/or the reaction frame used during testing. Isolation of a test nail through the shotcrete facing shall not affect the location of the reinforcing steel under the bearing plate. If necessary, provide casing for the unbonded length to allow grouting and completion of the nail subsequent to testing. Where temporary casing is provided, install the casing in a way that prevents any reaction between the casing and the grouted bond length of the nail and/or the stressing apparatus.

Apply and measure the test load with a hydraulic jack and pressure gauge. Graduate the pressure gauge in 0.7 MPa (100 psi) increments or less. The jack and pressure gauge shall have a pressure range not exceeding twice the anticipated maximum test pressure. Jack ram travel shall be sufficient to allow the test to be done without resetting the equipment.

Measure the nail head movement with a dial gauge capable of measuring to 0.025 mm (0.001 in.). The dial gauge shall have a travel sufficient to allow the test to be done without having to reset the gauge. Visually align the gauge to be parallel with the axis of the nail and support the gauge independently from the jack, wall, or reaction frame. Use two dial gauges when the test setup requires reaction against a soil cut face.

Perform proof tests by incrementally loading the proof test nail to a maximum test load of 1.50 DPL. Measure and record the nail movement at each load in the same manner as for verification tests. Monitor the test load by a jack pressure gauge with a sensitivity and range meeting the requirements of pressure gauges used for verification test nails. At load increments other than the maximum test load, hold the load long enough to obtain a stable reading. Incrementally load proof test nails according to the schedule below.

**Proof Test Loading Schedule**

| Load | Hold Time |
|---|---|
| Alignment | Until Stable |
| 0.25 DPL | Until Stable |
| 0.50 DPL | Until Stable |
| 0.75 DPL | Until Stable |
| 1.00 DPL | Until Stable |
| 1.25 DPL | Until Stable |
| Creep Test | See Below |

The Alignment Load shall be the minimum load required to align the testing apparatus and shall not exceed 0.05 DPL. Set dial gauges to "zero" after the alignment load has been applied.

Maintain all load increments within 5% of the intended load.

Depending on performance, perform either 10 minute or 60 minute creep tests at the maximum test load of 1.50 DPL. Start the creep period as soon as the maximum test load is applied and measure and record the nail movement at 1, 2, 3, 5, 6, and 10 minutes. Where the nail movement between 1 minute and 10 minutes exceeds 1 mm (0.04 in.), maintain the maximum test load an additional 50 minutes and record the movements at 20, 30, 50, and 60 minutes.

A test nail will be considered acceptable when:

1. A total creep movement of less than 1 mm (0.04 in.) is measured between the 1 and 10 minute readings or a total creep movement of less than 2 mm (0.08 in.). is measured between the 6 and 60 minute readings and the creep rate is linear or decreasing throughout the creep test load hold period.

2. The total measured movement at the maximum test load of 1.50 DPL exceeds 80% of the theoretical elastic elongation of the test nail unbonded length.

3. A pullout failure does not occur at the maximum test load. Pullout failure is defined as the load at which attempts to further increase the test load simply result in continued pullout movement of the test nail. Record the pullout failure load as part of the test data.

Successful proof tested nails meeting the above test acceptance criteria shall be incorporated as production nails. Finish test nails meeting the aforementioned requirements by satisfactorily grouting up the unbonded test length. If the unbonded test length of production proof test nails cannot be satisfactorily grouted subsequent to testing, the nail will not be accepted. Replace the nail and retest for acceptance.

If a test nail does not satisfy the acceptance criterion, determine the cause. Failing nails will not be accepted. Replace the nail and retest for acceptance.

Perform testing on nails adjacent to failing nails as directed. Replace additional failing nails and retest. Make modifications necessary to achieve the required capacity.

## METHOD OF MEASUREMENT

**644.04.01 Measurement.** Soil nails will be measured by the linear meter (linear foot), measured from the nail tip to the plane of cutoff.

Soil nail verification tests will be measured by the each.

## BASIS OF PAYMENT

**644.05.01 Payment.** The accepted quantities, measured as provided above, will be paid for at the contract price per unit of measurement for the pay items listed below that are shown in the proposal. Payment will be full compensation for the work prescribed in this Section.

Payment will be made under:

| Pay Item | Pay Unit |
|---|---|
| Soil Nail | Linear Meter (Linear Foot) |
| Verification Test | Each |

# SECTION 646

## DAMPPROOFING, WATERPROOFING, SEALING, AND MEMBRANES

DESCRIPTION

**646.01.01 General.** This work consists of bridge deck preparation and furnishing and applying dampproofing, waterproofing, sealants, and membrane materials to concrete and masonry elements.

MATERIALS

**646.02.01 Dampproofing and Waterproofing.** Primer shall conform to ASTM D41.

Asphalt shall conform to ASTM D449, Type I for below ground and Type III for above ground, except that the ductility for Type III shall be 5 minimum.

Glass fabric for waterproofing shall conform to ASTM D1668.

**646.02.02 Crack Sealant.** Manufacturers of crack sealants are listed in the QPL.

**646.02.03 Surface Sealant.** Manufacturers of surface sealants are listed in the QPL.

**646.02.04 Sheet Membrane.** Manufacturers of sheet membranes are listed in the QPL.

**646.02.05 Liquid Membrane.** Manufacturers of liquid membranes are listed in the QPL.

CONSTRUCTION

**646.03.01 Dampproofing.** Make concrete surfaces smooth and free of depressions and projections which might damage the dampproofing. The surface shall be dry and cleaned of dust and loose materials.

Do not apply primer or asphalt in wet weather, nor when the surface temperature is either below 4 °C (40 °F) or below that recommended by the manufacturer.

Apply a coating of primer and 2 moppings of asphalt. Begin dampproofing application at the low point of the surface being treated.

Apply primer at an approximate rate of 0.41 L/m$^2$ (0.09 gal/yd$^2$) and allow to dry before the first coat of asphalt is applied.

Apply asphalt at a temperature between 149 °C and 177 °C (300 °F and 350 °F). Apply each mopping of asphalt at the rate of approximately 1.6 L/m$^2$ (0.35 gal/yd$^2$). The total thickness of the 2 coats shall be approximately 2 mm (0.08 in.).

After the first mopping of asphalt has set sufficiently, mop on the second coating. Take special care to ensure that there are no skips in the coatings and that all surfaces are thoroughly covered.

**646.03.02 Waterproofing.** Make concrete surfaces smooth and free of depressions and projections which might damage the waterproofing. The surface shall be dry and cleaned of dust and loose materials.

Do not apply primer or asphalt in wet weather, nor when the surface temperature is either below 4 °C (40 °F) or below that recommended by the manufacturer.

Do not apply waterproofing until prepared to follow its application with the placement of the backfill within a sufficiently short time so that the waterproofing will not be damaged as a result of exposure to weathering. Remove waterproofing which loses its bond with the concrete and replace with acceptable waterproofing.

Apply a coating of primer and 2 layers of glass fabric within 3 moppings of asphalt.

Apply primer at an approximate rate of 0.41 L/m$^2$ (0.09 gal/yd$^2$) and allow to dry before the first coat of asphalt is applied.

Apply asphalt at a temperature between 149 °C and 177 °C (300 °F and 350 °F). Apply each mopping of asphalt at a rate not less than 1.6 L/m$^2$ (0.35 gal/yd$^2$) on horizontal surfaces and not less than 2.0 L/m$^2$ (0.44 gal/yd$^2$) on vertical surfaces.

Apply waterproofing across all expansion joints unless otherwise directed.

Begin at the lowest point of the surface and mop on asphalt slightly wider than half the width of the fabric. Immediately roll a strip of fabric of half the width of the roll onto the hot asphalt and carefully press into place so as to eliminate all air bubbles and obtain close conformity with the surface. Lay fabric so that drainage is over, and not against or along the laps. Mop asphalt on this first strip and an adjacent section of the surface of a width equal to slightly more than half the width of the fabric being used. Then roll a full width of the fabric into this asphalt, completely covering the first strip, and press into place as before. Mop this second strip and an adjacent section of the concrete surface with hot asphalt and shingle on the third strip of fabric so as to lap the first strip by not less than 50 mm (2 in.). Continue this process of lapping each strip of fabric at least 50 mm (2 in.) over the strip placed before the last strip until the entire surface is covered with 2 layers of fabric. Lap the ends at least 300 mm (12 in.).

Mop the entire surface with hot asphalt after all fabric is placed. Regulate the work so that at the close of the day's work all fabric in place is mopped. Take special care at all laps to see that they are thoroughly sealed down.

**646.03.03 Crack Sealant.** Prior to application, the concrete surfaces shall be dry according to the manufacturer's recommendations. Prior to starting work, submit material safety data sheets for the selected material.

Protect pedestrians, vehicles, private property, and the adjacent traveled way during application.

Arrange to have a skilled technical representative from the manufacturer on-site to provide training and guidance on mixing proportions, equipment, storage, handling, application, protective clothing, and safety. Have the qualified representative present prior to placement and on site until released by the Engineer.

During application, the concrete surface temperature shall be between 10 °C and 38 °C (50 °F and 100 °F) or as required by the manufacturer. Methods proposed to heat or cool the concrete surface shall be subject to approval.

Apply the sealant using methods and equipment recommended by the manufacturer. Apply sealant at an approximate rate of 0.41 L/m$^2$ (0.09 gal/yd$^2$). The application rate may be adjusted within the manufacturer's recommended range and as advised by the technical representative.

Flood surfaces with sealant allowing penetration and filling of all cracks. Redistribute the applied sealant in cracks by squeegees or brooms. The quantity of prepared sealant shall be no more than what is needed for application. A noticeable increase in viscosity prior to placement shall be cause for rejection.

Cover the treated area with dry sand at a rate of 1.0 kg/m$^2$ to 1.2 kg/m$^2$ (1.8 lb/yd$^2$ to 2.2 lb/yd$^2$), according to the manufacturer's recommendations or before the crack sealant has begun to cure. Provide sand such that 95% shall pass the 2.36 mm (No. 8) sieve, and 95% shall be retained on the 850 µm (No. 20) sieve. Spread sand by a mechanical spreader. The moisture content of the sand shall not exceed 1/2 of the aggregate absorption. Before the sealant begins to cure, fill areas with standing liquid with sand and finish to a uniform surface.

Do not permit traffic on the treated surface until the sand cover adheres sufficiently to resist brushing by hand.

**646.03.04 Surface Sealant.** Prior to application, the concrete surfaces shall be dry according to the manufacturer's recommendations. Before starting work, submit material safety data sheets for the selected material.

Protect pedestrians, vehicles, private property, and the adjacent traveled way during application.

Arrange to have a skilled technical representative from the manufacturer on-site to provide training and guidance on mixing proportions, equipment, storage, handling, application, protective clothing, and safety. Have the qualified representative present prior to placement and on site until released by the Engineer.

The surface temperature of areas receiving treatment shall be between 10 °C and 38 °C (50 °F and 100 °F) or within the temperature range recommended by the manufacturer. Do not apply material during rain, blowing winds, or other conditions that prevent proper application.

Apply the sealant using methods and equipment recommended by the manufacturer. Apply sealant at an approximate rate of 0.41 L/m$^2$ (0.09 gal/yd$^2$). The application rate may be adjusted within the manufacturer's recommended range and as advised by the technical representative. If required by the manufacturer, after application of the sealant, wet the concrete surface to insure proper reaction.

Use the sealant as supplied by the manufacturer and do not dilute or alter in any way. Do not allow traffic on the treated surface until the solution has completely penetrated, been wetted (if required), and is completely dry.

**646.03.05 Sheet and Liquid Membranes.** Prior to application, the concrete surfaces shall be dry according to the manufacturer's recommendations.

Before placing membranes, have the supplier furnish the following:

1. A technical representative to provide on-site training to contractor personnel on equipment and procedures for preparing concrete surfaces and placing the membrane. The technical representative shall be present for the initial application of the membrane and for subsequent applications as directed.

2. A letter from the technical representative denoting the specific contractor personnel that the representative has provided job specific training to and is deemed qualified to supervise installation of the membrane.

3. Health and safety training for personnel who are to handle the materials.

4. Material safety data sheets.

Apply the materials using methods and equipment recommended by the manufacturer.

Apply a primer if recommended by the manufacturer. Allow primer to dry until tack free before applying the membrane. Re-prime areas not covered with membrane within 24 hours.

Apply sheet membranes in a manner that a shingling effect is achieved in the direction that water will drain. Roll with hand rollers or other equipment to develop a firm and uniform bond with the primed concrete surface minimizing wrinkles and air bubbles.

At open joints, deck drains, and other locations as directed, cut the membrane sheet to extend into the opening and bond in place. Provide protection and take measures to ensure the function of bridge expansion joints and deck drains are not adversely impacted by the membrane installation.

Extend the membrane up faces of barriers and curbs as shown in the plans or as recommended by the manufacturer. Provide flashing, fitted coverings, or other approved materials around projecting conduits or other elements passing through the membrane.

Do not permit public traffic or non-essential construction traffic on prepared or primed surfaces. Patch damaged areas and areas with inadequate overlap according to the manufacturer's recommendations.

Apply suitable membrane top coat materials according to the membrane manufacturer's recommendations for subsequent placement of bituminous surfacing. Use paving equipment that will not damage the membrane during placement of bituminous surfacing.

**646.03.06 Bridge Deck Preparation.** Use power sweeping, air blasting, shot blasting, sand blasting, high pressure water washing, or steam cleaning methods to clean and prepare concrete surfaces for sealant and membrane applications. Do not unduly damage the concrete surface, remove or alter the existing surface texture, or expose the coarse aggregate of the concrete by the cleaning process.

Detergents not to exceed 2% by mass may be used to aid in the cleaning process.

Protect pedestrians, vehicles, private property, and the adjacent traveled way during cleaning and preparation.

Prepare concrete surfaces as prescribed herein and in accordance with the recommendations of the manufacturer of the sealant or membrane to be applied to the surface.

Remove all traces of curing compound, laitance, dust, dirt, salt, oil, asphalt, traffic stripes, pavement markings, and other foreign materials.

Before preparing the entire surface, clean and prepare a test area of 2.3 $m^2$ (25 $ft^2$) minimum using the proposed methods and equipment. The test area will be evaluated as to whether the methods and equipment can produce the required surface preparation. If the specified surface preparation cannot be achieved, provide new methods or equipment that can produce the specified surface preparation.

Provide written approval from the technical representative that proper surface preparation has been completed prior to commencing installation of the sealant or membrane.

Do not allow traffic on cleaned and prepared concrete surfaces.

Prior to applying sealants, power sweep the entire concrete surface and blow all loose material from the surface and visible cracks using high pressure air.

## METHOD OF MEASUREMENT

**646.04.01 Measurement.** Bridge deck preparation will be measured by the square meter (square yard).

Dampproofing and waterproofing will be measured by the square meter (square yard) of area covered.

Crack sealant and surface sealant will be measured by the liter (gallon) based on mixed material actually placed.

Sheet membrane and liquid membrane will be measured by the square meter (square yard) of area covered.

## BASIS OF PAYMENT

**646.05.01 Payment.** The accepted quantities, measured as provided above, will be paid for at the contract price per unit of measurement for the pay items listed below that are shown in the proposal. Payment will be full compensation for the work prescribed in this Section.

Payment will be made under:

| Pay Item | Pay Unit |
|---|---|
| Bridge Deck Preparation | Square Meter (Square Yard) |
| Dampproofing | Square Meter (Square Yard) |
| Waterproofing | Square Meter (Square Yard) |
| Crack Sealant | Liter (Gallon) |
| Surface Sealant | Liter (Gallon) |
| Sheet Membrane | Square Meter (Square Yard) |
| Liquid Membrane | Square Meter (Square Yard) |

# SECTION 660

## PNEUMATICALLY PLACED CONCRETE MORTAR

DESCRIPTION

**660.01.01 General.** This work consists of constructing reinforced pneumatically placed concrete mortar surfaces for soil nail retaining walls.

Pneumatically placed concrete mortar (shotcrete) consists of either dry mixed fine aggregate and Portland cement applied by a suitable mechanism, to which water is added immediately before its expulsion from the nozzle, or mortar premixed by mechanical methods and pneumatically applied through a nozzle onto the prepared surface.

Perform shotcrete construction concurrently with soil nail wall construction as specified in Section 644.

**660.01.02 Qualifications.** Use workers, including foremen, nozzlemen, and delivery equipment operators, experienced to perform the work. Shotcrete nozzlemen shall have experience on at least 3 projects in the past 3 years in similar shotcrete application work and demonstrate ability to satisfactorily place the shotcrete.

Initial qualification of nozzlemen will be based either on previous ACI certification or satisfactory completion of qualification test panels. The requirement for nozzlemen to shoot qualification test panels will be waived for nozzlemen who can submit documented proof they have been certified in accordance with the ACI 506.3R Guide to Certification of Shotcrete Nozzlemen. The Certification shall have been done by an ACI recognized shotcrete testing lab and/or recognized shotcreting consultant and have covered the type of shotcrete to be used (plain wet-mix, plain dry-mix). All nozzlemen will be required to periodically shoot production test panels during the course of the work at the frequency specified herein.

Give notification not less than 2 days prior to the shooting of qualification test panels to be used to qualify nozzlemen without previous ACI certification. Use the same shotcrete mix and equipment to make qualification test panels as those to be used for the soil nail wall shotcrete facing. Initial qualification of the nozzlemen will be based on a visual inspection of the shotcrete density and void structure and on achieving the specified 3 day and 28 day compressive strength requirements determined from test specimens extracted from the qualification test panels. Conduct qualification test panels, core extraction, and compressive strength testing in accordance with ACI 506.2 and AASHTO T24/ASTM C42, unless otherwise specified herein.

**660.01.03 Submittals.** Submit 5 copies of the following information for review and approval at least 15 days prior to beginning shotcrete placement:

1. Documentation of the nozzlemen's qualifications.

2. Proposed methods of shotcrete placement and of controlling and maintaining facing alignment and shotcrete thickness.

3. Shotcrete mix design in accordance with Subsection 501.02.05, except cores from test panels or production panels will be used instead of cylinders and they will be tested as specified herein.

4. Manufacturer Certificates of Compliance for drainage geotextile, geocomposite drain strip, drain grate and accessories, and PVC drain piping.

5. Formwork dimensions and details for casting the CIP facing over the shotcrete construction facing. Include details for formwork connections to the shotcrete facing and/or nails (if applicable), proposed concrete placement method and placement rates, and accompanying structural calculations verifying the structural adequacy of the formwork, connections, and shotcrete facing and/or nails to support the loading induced by the fluid CIP concrete. When anchors embedded into the shotcrete facing will be used to support the 1-sided CIP face form, include calculations illustrating the anchor design load (calculated as the design concrete fluid pressure times the anchor tributary area). The structural calculations shall be prepared and sealed by a Registered Professional Engineer licensed in the State of Nevada.

Approval or rejection of submittals will be given within 10 days after receipt of a complete submission. Do not begin shotcrete construction or incorporate materials into the work until the submittal requirements are satisfied and found acceptable. Changes or deviations from the approved submittals shall be re-submitted for approval. No adjustments in contract time will be allowed due to incomplete submittals.

A pre-construction meeting will be held prior to the start of wall construction. Attendance is mandatory. The shotcrete Contractor, if different than the soil nail specialty Contractor, shall attend.

MATERIALS

**660.02.01 General.** Materials shall conform to the following Sections:

Portland Cement ..... Section 701
Concrete Curing Materials and Admixtures ..... Section 702
Water ..... Section 722

Aggregate for shotcrete shall conform to Section 706 except the following combined gradation requirement shall apply:

| Sieve Size | Percent Passing by Weight |
|---|---|
| 12.5 mm (1/2 in.) | 100 |
| 9.50 mm (3/8 in.) | 90-100 |
| 4.75 mm (No. 4) | 70-85 |
| 2.36 mm (No. 8) | 50-70 |
| 1.18 mm (No. 16) | 35-55 |
| 600 µm (No. 30) | 20-35 |
| 300 µm (No. 50) | 8-20 |
| 150 µm (No. 100) | 2-10 |

Use Type V cement with a minimum of 20% Class F pozzolan by mass in all concrete. In lieu of this requirement, Type II cement with a minimum of 20% Class F pozzolan by mass or Type IP (MS) cement may be substituted therefore.

The combined mass of cement and pozzolan will be considered as the mass of the cement when determining compliance with the cement range and maximum water requirements of Table I of Subsection 501.02.05.

Welded wire fabric shall conform to ASTM A185, A496, or A497.

Reinforcing bars shall conform to AASHTO M31/ASTM A615, Grade 420 (60), deformed.

PVC pipe shall conform to ASTM D1785 Schedule 40 PVC.

Geocomposite drain strips shall conform to the following:

| GEOTEXTILE PROPERTY | TEST METHOD | REQUIREMENT |
|---|---|---|
| Grab Tensile Strength, N (lb) | ASTM D4632 | ≥ 445 ( ≥ 100) |
| Puncture Strength, N (lb) | ASTM D4833 | ≥ 226 ( ≥ 60) |
| Elongation, % | ASTM D4632 | ≥ 50 |
| Apparent Opening Size - AOS, mm (US Sieve) | ASTM D4751 | 0.125 ≤ AOS ≤ 0.25 (120 ≤ AOS ≤ 60) |
| Flow Rate, lpm/m$^2$ (gpm/ft$^2$) | ASTM D4491 | ≥ 4890 ( ≥ 120) |
| **CORE PROPERTY** | **TEST METHOD** | **REQUIREMENT** |
| Thickness, mm (in.) | ASTM D1777 | ≥ 10 ( ≥ 0.40) |
| Compressive Strength, kN/m$^2$ (lb/ft$^2$) | ASTM D1621 | ≥ 670 ( ≥ 14,000) |
| Flow Rate Per Unit Width, lpm/m gpm/ft | ASTM D4716 | ≥ 161 ( ≥ 13) |

Do not begin shotcrete placement until notification is given that the proposed mix design and method of placement are acceptable.

Proportion the shotcrete to be pumpable with the concrete pump furnished for the work, with a cementing materials content of at least 390 kg/m$^3$ (657 lb/yd$^3$) and water/cement ratio not greater than 0.50. Do not use admixtures unless approved.

Thoroughly mix admixtures into the shotcrete at the rate specified by the manufacturer. Accelerators, if used, must be compatible with the cement used, be non-corrosive to steel, and not promote other detrimental effects such as cracking or excessive shrinkage. The maximum allowable chloride ion content of all ingredients shall not exceed 0.10% when tested according to AASHTO T260.

Air entrainment is not required for temporary shotcrete construction facings.

Provide a shotcrete mix capable of attaining 14 MPa (2,000 psi) compressive strength in 3 days and 28 MPa (4,000 psi) in 28 days. The average compressive strength of each set of three test cores extracted from test panels or wall face must equal or exceed 85% of the specified compressive strength, with no individual core less than 75% of the specified compressive strength, in accordance with ASTM C42.

Aggregate and cement may be batched by weight or by volume in accordance with the requirements of ASTM C94 or AASHTO M241/ASTM C685. Use mixing equipment that thoroughly blends the materials in sufficient quantity to maintain placing continuity. Ready mix shotcrete shall comply with AASHTO M157. Batch, deliver, and place shotcrete within 90 minutes of mixing. The use of retarding admixtures may extend application time beyond 90 minutes, if approved.

Place time limit after mixing as per the manufacturers' recommendations.

## CONSTRUCTION

**660.03.01 General.** Both preconstruction test panels, to verify mix design strengths, and production test panels, for acceptance, are required. Perform shotcreting and coring of test panels by qualified personnel as directed. Provide equipment, materials, and personnel as necessary to obtain shotcrete cores for testing including construction of test panel boxes, field curing requirements and coring. Shotcrete final acceptance will be based on the 28 day strength.

Shotcrete production work may commence upon initial approval of the mix design, nozzlemen, and preconstruction test panels. The shotcrete work by a crew will be suspended if the test results for their work does not satisfy the strength requirements. Before resuming work, the crew shall shoot additional test panels and demonstrate that the shotcrete in the panels satisfies the specified strength requirements.

Construct at least one preconstruction test panel for each proposed mixture being considered and for each shooting position to be encountered on the job. These test panels may also be used to qualify nozzlemen. Make preconstruction test panels prior to the commencement of production work using the same equipment, materials, mixture proportions and procedures proposed for the job.

Make preconstruction test panels with minimum dimensions of 750 mm x 750 mm (30 in. x 30 in.) square and at least 100 mm (4 in.) thick. Slope the sides of preconstruction and production test panels at 45 degrees over the full panel thickness to release rebound.

Furnish at least one production test panel or, in lieu of production test panels, six 75 mm (3 in.) diameter cores taken from the shotcrete facing, during the first production application of shotcrete and henceforth for every 420 $m^2$ (500 $yd^2$), or fraction thereof, of shotcrete placed. Construct the production test panels simultaneously with the shotcrete facing installation when directed. Make production test panels with minimum full thickness dimensions of 450 mm x 450 mm (18 in. x 18 in.) square and at least 125 mm (5 in.) thick.

Immediately after shooting, field moist cure the test panels by covering and tightly wrapping with a sheet of material meeting the requirements of ASTM C171 until they are delivered to the testing lab or test specimens are extracted. Do not immerse the test panels in water. Do not further disturb test panels for the first 24 hours after shooting.

Provide at least six 75 mm (3 in.) diameter core samples cut from each preconstruction test panel and production test panel. Extract test specimens from test panels in the field or transport to another location for extraction. Keep panels in their forms when transported. Do not take cores from the outer 150 mm (6 in.) of test panels measured in from the top outside edges of the panel form. Trim the ends of the cores to provide test cylinders at least 75 mm (3 in.) long. Take cores from the wall face in lieu of making production test panels, at designated locations. Clearly mark the cores and container to identify the core locations and whether they are for preconstruction or production testing. Mark the section of the wall to correlate with the cores. Immediately wrap cores in wet burlap or material meeting requirements of ASTM C171 and seal in a plastic bag. The cores will be delivered to the testing lab within 48 hours of shooting the panels. Dispose of the remainder of the panels. When the test length of a core is less than twice the diameter, the correction factors given in ASTM C42 will be applied to obtain the compressive strength of individual cores. Three cores will be tested at 3 days and three cores will be tested at 28 days in accordance with ASTM C42.

Fill core holes in the wall by dry-packing with non-shrink patching mortar after the holes are cleaned and dampened. Do not fill core holes with shotcrete.

**660.03.02 Placing.** Clean the face of the excavation and other surfaces to be shotcreted of loose materials, mud, rebound, overspray, or other foreign matter that could prevent or reduce shotcrete bond. Avoid loosening, cracking, or shattering the ground during excavation and cleaning. Remove any surface material which is so loosened or damaged, to a sufficient depth to provide a base that is suitable to receive the shotcrete.

Divert water flow and remove standing water so that shotcrete placement will not be detrimentally affected by standing water.

Ensure that the thickness of shotcrete satisfies the minimum requirements shown on the plans by using shooting wires, thickness control pins, or other acceptable devices. Install thickness control devices normal to the surface such that they protrude the required shotcrete thickness outside the surface. Ensure that the front face of the shotcrete does not extend beyond the limits shown on the plans.

Do not place shotcrete on frozen surfaces.

Protect adjacent surfaces from overspray during shooting. Remove material that loosens as the shotcrete is applied.

Maintain a clean, dry, oil-free supply of compressed air sufficient for maintaining adequate nozzle velocity at all times. Use equipment capable of delivering the premixed material accurately, uniformly, and continuously through the delivery hose. Control shotcrete application thickness, nozzle technique, air pressure, and rate of shotcrete placement to prevent sagging or sloughing of freshly-applied shotcrete.

Apply the shotcrete from the lower part of the area upwards to prevent accumulation of rebound. Orient nozzle at a distance and approximately perpendicular to the working face so that rebound will be minimal and compaction will be maximized. Pay special attention to encapsulating reinforcement. Do not work rebound back into the construction.

Where shotcrete is used to complete the top ungrouted zone of the nail drill hole near the face, position the nozzle into the mouth of the drillhole to completely fill the void.

A clearly defined pattern of continuous horizontal or vertical ridges or depressions at the reinforcing elements after they are covered with shotcrete will be considered an indication of insufficient reinforcement cover or poor nozzle techniques. In this case, immediately suspend the application of shotcrete and implement corrective measures before resuming the shotcrete operations. The shotcreting procedure may be corrected by adjusting the nozzle distance and orientation, by insuring adequate cover over the reinforcement, by adjusting the water content of the shotcrete mix, or by other means. Adjustment in water content of wet-mix requires requalifying the shotcrete mix.

Taper construction joints uniformly toward the excavation face over a minimum distance equal to the thickness of the shotcrete layer. Provide a minimum reinforcement overlap at reinforcement splice joints as shown. Clean and wet the surface of a joint before adjacent shotcrete is applied.

Where shotcrete is used to complete the top ungrouted zone of the nail drill hole near the face, to the maximum extent practical, clean and dampen the upper grout surface to receive shotcrete, similar to a construction joint.

Finish shotcrete as an undisturbed gun finish as applied from the nozzle or a rough screeded finish. Repair shotcrete surface defects as soon as possible after placement. Curing of the shotcrete is not required.

Construct the shotcrete within the following tolerances:

| | |
|---|---|
| Horizontal location of wire mesh; rebar; headed studs on bearing plates, from plan location | ±16 mm (5/8 in.) |
| Headed studs location on bearing plate, from plan location | 6 mm (1/4 in.) |
| Spacing between reinforcing bars, from plan dimension | 25 mm (1 in.) |
| Reinforcing lap, from specified dimension | - 25mm (1 in.) |
| Thickness of shotcrete | - 10 mm (3/8 in.) |
| Nail head bearing plate, deviation from parallel to wall face | 10° |

Remove shotcrete extending into the CIP finish face section beyond the tolerances as shown or specified herein. Remove and replace shotcrete which exhibits segregation, honeycombing, delamination, voids, or sand pockets. In-place shotcrete determined not to meet the specified strength requirement will be subject to remediation as determined.

**660.03.03 Drainage.** Install and secure all elements of the wall drainage network as shown, specified herein, or as required to suit the site conditions. Install all elements of the drainage network prior to shotcreting.

Install geocomposite drain strips centered between the columns of nails as shown on the plans. The drain strips shall be at least 300 mm (12 in.) wide and placed with the geotextile side against the ground. Secure the strips to the excavation face and prevent shotcrete from contaminating the ground side of the geotextile. Provide continuous drain strips. Make splices with a 300 mm (12 in.) minimum overlap such that the flow of water is not impeded. Repair damage to the geocomposite drain strip, which may interrupt the flow of water.

Install connection pipes as shown. Connect pipes to the drain strips using either prefabricated drain grates as shown or using the alternate connection method described below. Install the drain grate per the manufacturer's recommendations. Seal the joint between the drain grate and the drain strip at the discharge end of the connector pipe to prevent shotcrete intrusion.

The alternative acceptable method for connection of the connector pipe to the drain strip involves cutting a hole slightly larger than the diameter of the pipe into the strip plastic core but not through the geotextile. Wrap both ends of the connection pipe in geotextile in a manner that prevents migration of fines through the pipe. Tape or seal the inlet end of the pipe where it penetrates the drain strip and the discharge end of the connector pipe in a manner that prevents penetration of shotcrete into the drain strip or pipe. To assure passage of groundwater from the drain strip into the connector pipe, slot the inlet end of the connector pipe at every 45 degrees around the perimeter of the pipe to a depth of 6 mm (1/4 in.).

Provide weepholes through the construction facing to drain water from behind the facing. Install as shown. Use PVC pipe to form the weephole through the shotcrete. Cover the end of the pipe contacting the soil with a drainage geotextile. Prevent shotcrete intrusion into the discharge end of the pipe.

**660.03.04 Weather Limitations.** Protect the shotcrete when the ambient temperature is below 0 °C (32 °F) and falling or when it is likely to be subjected to freezing temperatures before gaining sufficient strength. Maintain cold weather protection until the in-place compressive strength of the shotcrete is greater than 5 MPa (750 psi). Cold weather protection includes blankets, heating under tents, or other acceptable means. The temperature of the shotcrete mix, when deposited, shall be not less than 10 °C (50 °F) or more than 35 °C (95 °F).

Suspend shotcrete application during high winds and heavy rain unless suitable protective covers, enclosures, or wind breaks are installed. Remove and replace newly placed shotcrete exposed to rain that washes out cement or otherwise makes the shotcrete unacceptable. Provide a polyethylene film or equivalent for shotcrete protection.

**660.03.05 Attachment of Nail Head Bearing Plate and Nut.** Attach a bearing plate and nut to each nail head as shown on the plans. While the shotcrete is still plastic and before its initial set, uniformly seat the plate on the shotcrete by hand wrench tightening the nut. Where uniform contact between the plate and the shotcrete cannot be provided, set the plate in a bed of grout. After grout has set for 24 hours, hand wrench tighten the nut. Ensure bearing plates with headed studs are in intimate contact with the construction facing and the studs are located within the tolerances as shown or specified herein.

**660.03.06 CIP Concrete Form Connection to Shotcrete Facing.** When mechanical, grouted, or epoxied anchors embedded into the shotcrete facing are used to support a one-sided CIP face form, perform pullout testing of the embedded anchors in accordance with ASTM C900 and as modified herein. Perform pullout testing of installed anchors prior to attachment of the face form. Select test anchor locations to be representative of the full wall surface area to be covered.

For facing areas up to 420 $m^2$ (500 $yd^2$), perform a minimum of three flexure/shear pullout tests with the anchor located approximately mid-span between two adjacent nail heads and with the nail heads or other reaction points located approximately one-half the nail spacing from the anchor. For facing areas in excess of 420 $m^2$ (500 $yd^2$), perform one additional flexure/shear pullout test for each additional 210 $m^2$ (250 $yd^2$) of face area. Test these anchors to 1.5 times their required design load (calculated as the design concrete fluid pressure times the anchor tributary area).

Perform local punching shear pullout testing on 2% of the installed anchors. Place the load reaction support no closer to the edge of the anchor than the embedment depth of the anchor into the construction facing. Test these anchors to 2.0 times their required design load.

Modify the anchor and/or face form support system if the tested anchors do not meet the above test acceptance criteria. Modified anchor installation will require re-testing in accordance with the above testing criteria.

## METHOD OF MEASUREMENT

**660.04.01 Measurement.** Pneumatically placed concrete mortar will be measured by the square meter (square yard). The area to be measured will be the area lying in a plane of the outside front face of the structure as shown in the plans.

## BASIS OF PAYMENT

**660.05.01 Payment.** The accepted quantity, measured as provided above, will be paid for at the contract price per unit of measurement for the pay item listed below that is shown in the proposal. Payment will be full compensation for the work prescribed in this Section.

Payment will be made under:

| Pay Item | Pay Unit |
|---|---|
| Pneumatically Placed Concrete Mortar (depth) | Square Meter (Square Yard) |

# DIVISION III

# MATERIALS DETAILS

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# SECTION 701

## PORTLAND CEMENT

SCOPE

**701.01.01 Materials Covered.** This specification covers the types of Portland cement and the type of blended hydraulic cement. Unless otherwise provided, use Type II or Type V Portland cement or Type IP blended hydraulic cement.

PHYSICAL PROPERTIES AND TESTS

**701.03.01 Requirements.** Type II and Type V Portland cements shall conform to ASTM C150, except the cement shall not contain more than 0.60% equivalent alkalies by mass as calculated as $Na_2O$ plus 0.658 $K_2O$.

Type IP blended hydraulic cement shall conform to ASTM C595, except as follows:

(a) The pozzolan constituent shall conform to Subsection 702.03.05 and shall be a minimum of 20% by mass of the blended hydraulic cement.

(b) The cement used in the uniform blend shall meet the specification requirements outlined for Type II Portland cement.

# SECTION 702

## CONCRETE CURING MATERIALS AND ADMIXTURES

### SCOPE

**702.01.01 Materials Covered.** This specification covers concrete curing materials, air entraining admixtures and other chemical admixtures, and pozzolans.

### PHYSICAL PROPERTIES AND TESTS

**702.03.01 Curing Materials.** Curing materials shall conform to the requirements of the following tests:

(a) Burlap Cloth made from Jute or Kenaf ..... AASHTO M182
(b) Waterproof Paper for Curing Concrete ..... ASTM C171
(c) Liquid Membrane-Forming Compounds for Curing Concrete ..... ASTM C309, Type 1D
(d) White Pigmented Curing Compound-Wax Base ..... ASTM C309, Type 2, Class A*
(e) White Polyethylene Sheeting (film) for Curing Concrete ..... ASTM C171
* Except: The loss of water from the surface in the water retention test shall not exceed 0.45 kg/m$^2$ (1.50 oz/ft$^2$) in 72 hours.

Curing compounds shall be tested and certified by a reputable testing laboratory recognized by the Department.

Use curing compounds listed in the QPL.

**702.03.02 Air-Entraining Admixtures.** Air-entraining admixtures shall conform to ASTM C260.

**702.03.03 Admixtures Other Than Air-Entraining.** Admixtures shall conform to ASTM C494. The admixtures may be tested by Test Method No. CALIF. 530.

**702.03.04 Bridge Deck Curing Compound.** Bridge deck curing compound shall be a white pigmented curing compound conforming to ASTM C309, Type 2, Class B. The resin type shall be poly-alpha-methylstyrene and the loss of water from the surface in the water retention test shall not exceed 0.15 kg/m$^2$ (0.50 oz/ft$^2$) in 24 hours nor more than 0.45 kg/m$^2$ (1.50 oz/ft$^2$) in 72 hours.

**702.03.05 Pozzolans.** Pozzolanic admixtures shall be Class C, Class F, or Class N conforming to ASTM C618, except the loss on ignition shall not exceed 5%.

Use pozzolans listed in the QPL.

The laboratory furnishing test data must be inspected by the Cement and Concrete Reference Laboratory (CCRL) of the National Institute of Standards and Technology, Gaithersburg, Maryland. In addition, the laboratory must authorize reports of said inspections to be sent to the Department's Materials Division for review.

If said inspection reports indicate that procedures or equipment used in the testing of pozzolan are substandard, test data from that laboratory will not be accepted.

A Certificate of Compliance from the supplier shall accompany each shipment of pozzolan.

**702.03.06 Slag Cement and Silica Fume.** Slag cement shall be Grade 120 and conform to ASTM C989. A Certificate of Compliance from the supplier shall accompany each shipment of slag cement. Provide samples upon request.

Silica fume shall conform to ASTM C1240. A Certificate of Compliance from the supplier shall accompany each shipment of silica fume.

# SECTION 703

## BITUMINOUS MATERIALS

### SCOPE

**703.01.01 Materials Covered.** This specification covers the quality of asphalt cement, cutback asphalt, and emulsified asphalt.

### REQUIREMENTS

**703.02.01 Demerit Schedule.** Bituminous material failing the requirements of the tests hereinafter prescribed shall be subject to the provisions of Subsection 109.02. Bituminous materials that cannot be tested by any of the specified test procedures due to the inherent nature of the material will be assessed 21 demerits.

For asphalt cements, demerits will be assessed on a prorated basis on the difference between the LIMIT WITH TOLERANCE and the REJECTION LIMIT.

For cutback asphalts and emulsified asphalts, demerits will be assessed for each increment of noncompliance.

Demerit values will be rounded down to the nearest whole demerit.

**703.02.02 Contractor's Responsibility.** When shipment of materials arrive on the project after normal working hours, give notice sufficiently in advance to allow arrangements for an inspector to be present when the material is sampled.

### PHYSICAL PROPERTIES AND TESTS

**703.03.01 Bill of Lading and Certificate of Compliance.** A bill of lading and certificate of compliance shall be submitted for every load of bituminous material.

The bill of lading shall include the following data:

1. Date of shipment and shipping point.
2. Car initials and number of truck transport delivery ticket number.
3. Destination and consignee.
4. State contract number (or State purchase order number, if applicable).
5. Type, grade, quantity, and temperature of material loaded.
6. Signature of shipper or authorized representative.

**703.03.02 Asphalt Cements.** Prepare asphalt cement by the distillation of crude petroleum. Provide homogenous asphalt, free from water, and non-foaming when heated to 175 °C (347 °F).

Asphalt cements submitted for mix designs shall meet the specification requirements, without tolerances. The tolerance applies to production samples only.

Asphalt cements shall conform to the requirements herein.

## ASPHALT CEMENT, GRADE PG 64-28NV

| TEST | TEST METHOD | REQUIREMENT |
|---|---|---|
| **Tests on Original Binder:** | | |
| Flash Point, °C | AASHTO T48 | 230 Min. |
| Viscosity @ 135 °C, Pa·s | AASHTO T316 | 3.00 Max. |
| Dynamic Shear, G*/sin δ , Test Temp 64 °C @ 10 rad/s, kPa | AASHTO T315 | 1.00 Min. |
| Ductility @ 4 °C, 5 cm/min, cm | Nev. T746 | 50 Min. |
| Toughness, Inch·lb | Nev. T745 | 110 Min. |
| Tenacity, Inch·lb | Nev. T745 | 75 Min. |
| Solubility, % | AASHTO T44 | 99.0 Min. |
| Sieve, Particulates Retained | Nev. T730 | 0 |
| **Tests on Residue from R.T.F.O., Nev. T728:** | | |
| Mass Loss, % | Nev. T728 | 1.00 Max. |
| Dynamic Shear, G*/sin δ, Test Temp 64 °C @ 10 rad/s, kPa | AASHTO T315 | 2.20 Min. |
| Ductility @ 4 °C, 5 cm/min, cm | Nev. T746 | 25 Min. |
| **Tests on Residue from Pressure Aging Vessel, AASHTO R28 @ 100 °C:** | | |
| Dynamic Shear, G*sin δ, Test Temp 22 °C @ 10 rad/s, kPa | AASHTO T315 | 5000 Max. |
| Creep Stiffness, S, Test Temp –18 °C @ 60 sec, MPa | AASHTO T313 | 300 Max. |
| Creep Stiffness, m-value, Test Temp –18 °C @ 60 sec | AASHTO T313 | 0.300 Min. |

Blend the PG 64-28NV at the asphalt terminal/refinery and deliver as a completed mixture to the job site. Do not transport PG 64-28NV by railroad car.

Asphalt Cement, Grade PG 64-28NV not conforming to the requirements specified herein will be assessed demerits according to the following schedule.

| TEST | LIMIT WITH TOLERANCE | REJECTION LIMIT | DEMERITS |
|---|---|---|---|
| Flash Point, °C | 222 Min. | 163 Min. | 21 |
| Viscosity, Pa·s | 3.21 Max. | 3.50 Max. | 21 |
| Dynamic Shear, Original Binder, kPa | 0.90 Min. | 0.75 Min. | 21 |
| Ductility, Original Binder, cm | 50 Min. | 29 Min. | 21 |
| Toughness, Inch·lb | 110 Min. | 57 Min. | 21 |
| Tenacity, Inch·lb | 75 Min. | 22 Min. | 21 |
| Solubility, % | 98.9 | 98.6 | 21 |
| Sieve | 1 | 10 | 21 |
| Mass Loss, % | 1.00 Max. | 1.01 Max. | 31 |
| Dynamic Shear, R.T.F.O., kPa | 1.98 Min. | 1.65 Min. | 21 |
| Ductility, R.T.F.O., cm | 25 Min. | 4 Min. | 21 |
| Dynamic Shear, P.A.V., kPa | 5500 Max. | 6250 Max. | 21 |
| Creep Stiffness, S, MPa | 330 Max. | 375 Max. | 21 |
| Creep Stiffness, m-value | 0.290 Min. | 0.245 Min. | 21 |

## ASPHALT CEMENT, GRADE PG 76-22NV

| TEST | TEST METHOD | REQUIREMENT |
|---|---|---|
| **Tests on Original Binder:** | | |
| Flash Point, °C | AASHTO T48 | 230 Min. |
| Viscosity @ 135 °C, Pa·s | AASHTO T316 | 3.00 Max. |
| Dynamic Shear, G*/sin $\delta$, Test Temp 76 °C @ 10 rad/s, kPa | AASHTO T315 | 1.30 Min. |
| Ductility @ 4 °C, 5 cm/min, cm | Nev. T746 | 20 Min. |
| Solubility, % | AASHTO T44 | 99.0 Min. |
| Sieve, Particulates Retained | Nev. T730 | 0 |
| Polymer Content, % by mass | (a) | 3.0 Min. |
| **Tests on Residue from R.T.F.O., Nev. T728:** | | |
| Mass Loss, % | Nev. T728 | 1.00 Max. |
| Creep Recovery, $R_{3.2}$, Test Temp 76 °C @ 3.2 kPa, % | AASHTO T350 | 30.0 Min. |
| Non-Recoverable Creep Compliance, $J_{nr3.2}$, Test Temp 76 °C @ 3.2 kPa, $kPa^{-1}$ | AASHTO T350 | 2.0 Max. |
| Non-Recoverable Creep Compliance Difference, $J_{nrdiff}$, % | AASHTO T350 | Report |
| **Tests on Residue from Pressure Aging Vessel, AASHTO R28 @ 110 °C:** | | |
| Dynamic Shear, G*sin $\delta$ , Test Temp 31 °C @ 10 rad/s, kPa | AASHTO T315 | 5000 Max. |
| Creep Stiffness, S, Test Temp –12 °C @ 60 sec, MPa | AASHTO T313 | 300 Max. |
| Creep Stiffness, m-value, Test Temp –12 °C @ 60 sec | AASHTO T313 | 0.300 Min. |

(a) Certificates of compliance provided for the material shall certify that the minimum polymer content is present. The Department reserves the right to test for polymer content according to AASHTO T302. If testing indicates the minimum polymer content is not present, the material may no longer be conditionally accepted based on certificate of compliance.

Upon request, furnish samples of the base asphalt and the polymer for testing to verify polymer content.

Blend the PG 76-22NV at the asphalt terminal/refinery and deliver as a completed mixture to the job site. Do not transport PG 76-22NV by railroad car.

Asphalt Cement, Grade PG 76-22NV not conforming to the requirements specified herein will be assessed demerits according to the following schedule.

| TEST | LIMIT WITH TOLERANCE | REJECTION LIMIT | DEMERITS |
|---|---|---|---|
| Flash Point, °C | 222 Min. | 163 Min. | 21 |
| Viscosity, Pa·s | 3.21 Max. | 3.50 Max. | 21 |
| Dynamic Shear, Original Binder, kPa | 1.17 Min. | 0.99 Min. | 21 |
| Ductility, Original Binder, cm | 20 Min. | 0 | 21 |
| Solubility, % | 98.9 | 98.6 | 21 |
| Sieve | 1 | 10 | 21 |
| Polymer Content, % | 3.0 Min. | 3.0 Min. | 31 |
| Mass Loss, % | 1.00 Max. | 1.01 Max. | 31 |
| Creep Recovery, % | 27.0 Min. | 22.5 Min. | 21 |
| Non-Recoverable Creep Compliance, $kPa^{-1}$ | 2.2 Max. | 4.0 Max. | 21 |
| Dynamic Shear, P.A.V., kPa | 5500 Max. | 6250 Max. | 21 |
| Creep Stiffness, S, MPa | 330 Max. | 375 Max. | 21 |
| Creep Stiffness, m-value | 0.280 Min. | 0.235 Min. | 21 |

## ASPHALT CEMENT, GRADE PG 64-28NVTR

| TEST | TEST METHOD | REQUIREMENT |
|---|---|---|
| **Tests on Original Binder:** | | |
| Flash Point, °C | AASHTO T48 | 230 Min. |
| Viscosity @ 135 °C, Pa·s | AASHTO T316 | 3.00 Max. |
| Dynamic Shear, G*/sin δ , Test Temp 64 °C @ 10 rad/s, kPa | AASHTO T315 | 1.00 Min. |
| Ductility @ 4 °C, 5 cm/min, cm | Nev. T746 | 50 Min. |
| Toughness, Inch·lb | Nev. T745 | 110 Min. |
| Tenacity, Inch·lb | Nev. T745 | 75 Min. |
| Solubility, %, Sample Size 0.50 to 1.00 g | AASHTO T44 | 96.0 Min. |
| Sieve, Particulates Retained | Nev. T730 | 0 |
| Rubber Content, % by mass | (a) | 10.0 Min. |
| **Tests on Residue from R.T.F.O., Nev. T728:** | | |
| Mass Loss, % | Nev. T728 | 1.00 Max. |
| Dynamic Shear, G*/sin δ, Test Temp 64 °C @ 10 rad/s, kPa | AASHTO T315 | 2.20 Min. |
| Ductility @ 4 °C, 5 cm/min, cm | Nev. T746 | 25 Min. |
| **Tests on Residue from Pressure Aging Vessel, AASHTO R28 @ 100 °C:** | | |
| Dynamic Shear, G*sin δ, Test Temp 22 °C @ 10 rad/s, kPa | AASHTO T315 | 5000 Max. |
| Creep Stiffness, S, Test Temp –18 °C @ 60 sec, MPa | AASHTO T313 | 300 Max. |
| Creep Stiffness, m-value, Test Temp –18 °C @ 60 sec | AASHTO T313 | 0.300 Min. |

(a) Certificates of compliance provided for the material shall certify that the minimum rubber content is present.

Blend the PG 64-28NVTR at the asphalt terminal/refinery and deliver as a completed mixture to the job site. Do not transport PG 64-28NVTR by railroad car.

Asphalt Cement, Grade PG 64-28NVTR not conforming to the requirements specified herein will be assessed demerits according to the following schedule.

| TEST | LIMIT WITH TOLERANCE | REJECTION LIMIT | DEMERITS |
|---|---|---|---|
| Flash Point, °C | 222 Min. | 163 Min. | 21 |
| Viscosity, Pa·s | 3.21 Max. | 3.50 Max. | 21 |
| Dynamic Shear, Original Binder, kPa | 0.90 Min. | 0.75 Min. | 21 |
| Ductility, Original Binder, cm | 50 Min. | 29 Min. | 21 |
| Toughness, Inch·lb | 110 Min. | 57 Min. | 21 |
| Tenacity, Inch·lb | 75 Min. | 22 Min. | 21 |
| Solubility, % | 95.9 | 95.0 | 21 |
| Sieve | 1 | 10 | 21 |
| Mass Loss, % | 1.00 Max. | 1.01 Max. | 31 |
| Dynamic Shear, R.T.F.O., kPa | 1.98 Min. | 1.65 Min. | 21 |
| Ductility, R.T.F.O., cm | 25 Min. | 4 Min. | 21 |
| Dynamic Shear, P.A.V., kPa | 5500 Max. | 6250 Max. | 21 |
| Creep Stiffness, S, MPa | 330 Max. | 375 Max. | 21 |
| Creep Stiffness, m-value | 0.290 Min. | 0.245 Min. | 21 |

## ASPHALT CEMENT, GRADE PG 76-22NVTR

| TEST | TEST METHOD | REQUIREMENT |
|---|---|---|
| **Tests on Original Binder:** | | |
| Flash Point, °C | AASHTO T48 | 230 Min. |
| Viscosity @ 135 °C, Pa·s | AASHTO T316 | 3.00 Max. |
| Dynamic Shear, G*/sin $\delta$, Test Temp 76 °C @ 10 rad/s, kPa | AASHTO T315 | 1.30 Min. |
| Ductility @ 4 °C, 5 cm/min, cm | Nev. T746 | 20 Min. |
| Solubility, %, Sample Size 0.50 to 1.00 g | AASHTO T44 | 96.0 Min. |
| Sieve, Particulates Retained | Nev. T730 | 0 |
| Rubber Content, % by mass | (a) | 10.0 Min. |
| **Tests on Residue from R.T.F.O., Nev. T728:** | | |
| Mass Loss, % | Nev. T728 | 1.00 Max. |
| Creep Recovery, $R_{3.2}$, Test Temp 76 °C @ 3.2 kPa, % | AASHTO T350 | 30.0 Min. |
| Non-Recoverable Creep Compliance, $J_{nr3.2}$, Test Temp 76 °C @ 3.2 kPa, $kPa^{-1}$ | AASHTO T350 | 2.0 Max. |
| Non-Recoverable Creep Compliance Difference, $J_{nrdiff}$, % | AASHTO T350 | Report |
| **Tests on Residue from Pressure Aging Vessel, AASHTO R28 @ 110 °C:** | | |
| Dynamic Shear, G*sin $\delta$, Test Temp 31 °C @ 10 rad/s, kPa | AASHTO T315 | 5000 Max. |
| Creep Stiffness, S, Test Temp –12 °C @ 60 sec, MPa | AASHTO T313 | 300 Max. |
| Creep Stiffness, m-value, Test Temp –12 °C @ 60 sec | AASHTO T313 | 0.300 Min. |

(a) Certificates of compliance provided for the material shall certify that the minimum rubber content is present.

Blend the PG 76-22NVTR at the asphalt terminal/refinery and deliver as a completed mixture to the job site. Do not transport PG 76-22NVTR by railroad car.

Asphalt Cement, Grade PG 76-22NVTR not conforming to the requirements specified herein will be assessed demerits according to the following schedule.

| TEST | LIMIT WITH TOLERANCE | REJECTION LIMIT | DEMERITS |
|---|---|---|---|
| Flash Point, °C | 222 Min. | 163 Min. | 21 |
| Viscosity, Pa·s | 3.21 Max. | 3.50 Max. | 21 |
| Dynamic Shear, Original Binder, kPa | 1.17 Min. | 0.99 Min. | 21 |
| Ductility, Original Binder, cm | 20 Min. | 0 Min. | 21 |
| Solubility, % | 95.9 | 95.0 | 21 |
| Sieve | 1 | 10 | 21 |
| Mass Loss, % | 1.00 Max. | 1.01 Max. | 31 |
| Creep Recovery, % | 27.0 Min. | 22.5 Min. | 21 |
| Non-Recoverable Creep Compliance, $kPa^{-1}$ | 2.2 Max. | 4.0 Max. | 21 |
| Dynamic Shear, P.A.V., kPa | 5500 Max. | 6250 Max. | 21 |
| Creep Stiffness, S, MPa | 330 Max. | 375 Max. | 21 |
| Creep Stiffness, m-value | 0.280 Min. | 0.235 Min. | 21 |

## ASPHALT CEMENT, GRADE PG 58-28

| TEST | TEST METHOD | REQUIREMENT |
|---|---|---|
| **Tests on Original Binder:** | | |
| Flash Point, °C | AASHTO T48 | 230 Min. |
| Viscosity @ 135 °C, Pa·s | AASHTO T316 | 3.00 Max. |
| Dynamic Shear, G*/sin δ, Test Temp 58 °C @ 10 rad/s, kPa | AASHTO T315 | 1.00 Min. |
| Solubility, % | AASHTO T44 | 99.0 Min. |
| **Tests on Residue from R.T.F.O., Nev. T728:** | | |
| Mass Loss, % | Nev. T728 | 1.00 Max. |
| Dynamic Shear, G*/sin δ, Test Temp 58 °C @ 10 rad/s, kPa | AASHTO T315 | 2.20 Min. |
| **Tests on Residue from Pressure Aging Vessel, AASHTO R28 @ 100 °C:** | | |
| Dynamic Shear, G*sin δ, Test Temp 19 °C @ 10 rad/s, kPa | AASHTO T315 | 5000 Max. |
| Creep Stiffness, S, Test Temp –18 °C @ 60 sec, MPa | AASHTO T313 | 300 Max. |
| Creep Stiffness, m-value, Test Temp –18 °C @ 60 sec | AASHTO T313 | 0.300 Min. |

## ASPHALT CEMENT, GRADE PG 64-16

| TEST | TEST METHOD | REQUIREMENT |
|---|---|---|
| **Tests on Original Binder:** | | |
| Flash Point, °C | AASHTO T48 | 230 Min. |
| Viscosity @ 135 °C, Pa·s | AASHTO T316 | 3.00 Max. |
| Dynamic Shear, G*/sin δ, Test Temp 64 °C @ 10 rad/s, kPa | AASHTO T315 | 1.00 Min. |
| Solubility, % | AASHTO T44 | 99.0 Min. |
| **Tests on Residue from R.T.F.O., Nev. T728:** | | |
| Mass Loss, % | Nev. T728 | 1.00 Max. |
| Dynamic Shear, G*/sin δ, Test Temp 64 °C @ 10 rad/s, kPa | AASHTO T315 | 2.20 Min. |
| **Tests on Residue from Pressure Aging Vessel, AASHTO R28 @ 100 °C:** | | |
| Dynamic Shear, G*sin δ, Test Temp 28 °C @ 10 rad/s, kPa | AASHTO T315 | 5000 Max. |
| Creep Stiffness, S, Test Temp –6 °C @ 60 sec, MPa | AASHTO T313 | 300 Max. |
| Creep Stiffness, m-value, Test Temp –6 °C @ 60 sec | AASHTO T313 | 0.300 Min. |

## ASPHALT CEMENT, GRADE PG 64-22

| TEST | TEST METHOD | REQUIREMENT |
|---|---|---|
| **Tests on Original Binder:** | | |
| Flash Point, °C | AASHTO T48 | 230 Min. |
| Viscosity @ 135 °C, Pa·s | AASHTO T316 | 3.00 Max. |
| Dynamic Shear, G*/sin δ, Test Temp 64 °C @ 10 rad/s, kPa | AASHTO T315 | 1.00 Min. |
| Solubility, % | AASHTO T44 | 99.0 Min. |
| **Tests on Residue from R.T.F.O., Nev. T728:** | | |
| Mass Loss, % | Nev. T728 | 1.00 Max. |
| Dynamic Shear, G*/sin δ, Test Temp 64 °C @ 10 rad/s, kPa | AASHTO T315 | 2.20 Min. |
| **Tests on Residue from Pressure Aging Vessel, AASHTO R28 @ 100 °C:** | | |
| Dynamic Shear, G*sin δ, Test Temp 25 °C @ 10 rad/s, kPa | AASHTO T315 | 5000 Max. |
| Creep Stiffness, S, Test Temp –12 °C @ 60 sec, MPa | AASHTO T313 | 300 Max. |
| Creep Stiffness, m-value, Test Temp –12 °C @ 60 sec | AASHTO T313 | 0.300 Min. |

## ASPHALT CEMENT, GRADE PG 70-16

| TEST | TEST METHOD | REQUIREMENT |
|---|---|---|
| **Tests on Original Binder:** | | |
| Flash Point, °C | AASHTO T48 | 230 Min. |
| Viscosity @ 135 °C, Pa·s | AASHTO T316 | 3.00 Max. |
| Dynamic Shear, G*/sin δ, Test Temp 70 °C @ 10 rad/s, kPa | AASHTO T315 | 1.00 Min. |
| Solubility, % | AASHTO T44 | 99.0 Min. |
| **Tests on Residue from R.T.F.O., Nev. T728:** | | |
| Mass Loss, % | Nev. T728 | 1.00 Max. |
| Dynamic Shear, G*/sin δ, Test Temp 70 °C @ 10 rad/s, kPa | AASHTO T315 | 2.20 Min. |
| **Tests on Residue from Pressure Aging Vessel, AASHTO R28 @ 110 °C:** | | |
| Dynamic Shear, G*sin δ, Test Temp 31 °C @ 10 rad/s, kPa | AASHTO T315 | 5000 Max. |
| Creep Stiffness, S, Test Temp –6 °C @ 60 sec, MPa | AASHTO T313 | 300 Max. |
| Creep Stiffness, m-value, Test Temp –6 °C @ 60 sec | AASHTO T313 | 0.300 Min. |

Asphalt Cement, Grades PG 58-28, 64-16, 64-22, and 70-16 not conforming to the requirements specified herein will be assessed demerits according to the following schedule.

| TEST | LIMIT WITH TOLERANCE | REJECTION LIMIT | DEMERITS |
|---|---|---|---|
| Flash Point, °C | 222 Min. | 163 Min. | 21 |
| Viscosity, Pa·s | 3.21 Max. | 3.50 Max. | 21 |
| Dynamic Shear, Original Binder, kPa | 0.90 Min. | 0.75 Min. | 21 |
| Solubility, % | 98.9 | 98.6 | 21 |
| Mass Loss, % | 1.00 Max. | 1.01 Max. | 31 |
| Dynamic Shear, R.T.F.O., kPa | 1.98 Min. | 1.65 Min. | 21 |
| Dynamic Shear, P.A.V., kPa | 5500 Max. | 6250 Max. | 21 |
| Creep Stiffness, S, MPa | 330 Max. | 375 Max. | 21 |
| Creep Stiffness, m-value | 0.290 Min. | 0.245 Min. | 21 |

**703.03.03 Cutback Asphalts.** Cutback asphalts are produced by fluxing an asphaltic base with suitable petroleum distillates. Medium curing products are designated by the letters MC. Slow curing products are designated by the letters SC. Cutback asphalts shall conform to the requirements herein.

When tolerances are expressed in terms of percent, the allowable deviation is calculated as the indicated percentage at the upper or lower specification limit, whichever is applicable.

## MEDIUM CURING CUTBACK ASPHALTS

| TEST | TEST METHOD | MC-70NV | MC-250 | MC-800 | MC-3000 | TOLERANCE |
|---|---|---|---|---|---|---|
| **Tests on Original Asphalt:** | | | | | | |
| Flash Point, °C (°F) | AASHTO T79 | 38 Min. (100 Min.) | 66 Min. (150 Min.) | 66 Min. (150 Min.) | 66 Min. (150 Min.) | 8 °C (15 °F) |
| Kinematic Viscosity @ 60 °C, mm²/s (140 °F, cSt) | AASHTO T201 | 70-250 (70-250) | 250-500 (250-500) | 800-1600 (800-1600) | 3000-6000 (3000-6000) | (a) |
| Water Mass, % | ASTM D95 | 2.0 Max. | 0.2 Max. | 0.2 Max. | 0.2 Max. | 0.1 |
| **Distillation: Distillate, % by volume of total Distillate to 360 °C (680 °F):** | | | | | | |
| to 225 °C (437 °F) | AASHTO T78 | 25 Max. | 10 Max. | — | — | 1.0 |
| to 260 °C (500 °F) | AASHTO T78 | 20-70 | 15-55 | 35 Max. | 15 Max. | 1.0 |
| to 316 °C (600 °F) | AASHTO T78 | 65-95 | 60-87 | 45-80 | 15-75 | 1.0 |
| **Residue from Distillation to 360 °C (680 °F):** | | | | | | |
| Volume % by difference | AASHTO T78 | 55 Min. | 67 Min. | 75 Min. | 80 Min. | 1.0 |
| **Tests on Residue from Distillation:** | | | | | | |
| Viscosity @ 60 °C, Pa·s (140 °F, Poises) | AASHTO T202 | 30-120 (300-1200) | 30-120 (300-1200) | 30-120 (300-1200) | 30-120 (300-1200) | 7% |
| Ductility @ 25 °C (77 °F), 5 cm/min, cm | AASHTO T51 | 100 Min. | 100 Min. | 100 Min. | 100 Min. | 20% |
| Solubility, % | AASHTO T44 | 99.0 Min. | 99.0 Min. | 99.0 Min. | 99.0 Min. | 0.10 |

(a) Below 3,000 = 1.5%, 3,000 to 6,000 = 2.0%.

Medium curing cutback asphalts not conforming to the requirements specified herein will be assessed demerits according to the following schedule.

| TEST | INCREMENT | DEMERITS |
|---|---|---|
| Kinematic Viscosity, MC-70NV | 4 mm²/s (cSt) above maximum or below minimum | 1 |
| Kinematic Viscosity, MC-250 | 10 mm²/s (cSt) above maximum or below minimum | 1 |
| Kinematic Viscosity, MC-800 | 30 mm²/s (cSt) above maximum or below minimum | 1 |
| Kinematic Viscosity, MC-3000 | 100 mm²/s (cSt) above maximum or below minimum | 1 |
| Water Mass, % | 0.1% above maximum | 1 |
| Distillate, % by volume | 2% above maximum or below minimum, per fraction | 1 |
| Residue, volume % by difference | 1% below minimum | 1 |
| Viscosity | 1 Pa·s (10 Poises) above maximum or below minimum | 1 |
| Solubility, % | 0.01% below minimum | 1 |

## SLOW CURING CUTBACK ASPHALTS

| TEST | TEST METHOD | SC-70 | SC-250 | SC-800 | SC-3000 | TOLERANCE |
|---|---|---|---|---|---|---|
| **Tests on Original Asphalt:** | | | | | | |
| Flash Point, °C (°F) | AASHTO T48 | 66 Min. (150 Min.) | 79 Min. (175 Min.) | 93 Min. (200 Min.) | 107 Min. (225 Min.) | 8 °C (15 °F) |
| Kinematic Viscosity @ 60 °C, mm²/s (140 °F, cSt) | AASHTO T201 | 70-140 (70-140) | 250-500 (250-500) | 800-1600 (800-1600) | 3000-6000 (3000-6000) | (a) |
| Water Mass, % | ASTM D95 | 0.5 Max. | 0.5 Max. | 0.5 Max. | 0.5 Max. | 0.1 |
| **Distillation: Total Distillate to 360 °C (680 °F):** | | | | | | |
| Volume % | AASHTO T78 | 10-30 | 4-20 | 2-12 | 5 Max. | 1.0 |
| **Tests on Residue from Distillation:** | | | | | | |
| Kinematic Viscosity @ 60 °C, mm²/s (140 °F, cSt) | AASHTO T201 | 400-7000 (400-7000) | 800-10000 (800-10000) | 2000-16000 (2000-16000) | 4000-35000 (4000-35000) | (a) |
| Ductility @ 25 °C (77 °F), 5 cm/min, cm | AASHTO T51 | 100 Min. | 100 Min. | 100 Min. | 100 Min. | 20% |
| Solubility, % | AASHTO T44 | 99.0 Min | 99.0 Min. | 99.0 Min. | 99.0 Min. | 0.10 |

(a) Below 3,000 = 1.5%, 3,000 to 6,000 = 2.0%, above 6,000 = 8.9%.

Slow curing cutback asphalts not conforming to the requirements specified herein will be assessed demerits according to the following schedule.

| TEST | INCREMENT | DEMERITS |
|---|---|---|
| Kinematic Viscosity, SC-70 | 4 mm²/s (cSt) above maximum or below minimum | 1 |
| Kinematic Viscosity, SC-250 | 10 mm²/s (cSt) above maximum or below minimum | 1 |
| Kinematic Viscosity, SC-800 | 30 mm²/s (cSt) above maximum or below minimum | 1 |
| Kinematic Viscosity, SC-3000 | 100 mm²/s (cSt) above maximum or below minimum | 1 |
| Water Mass, % | 0.1% above maximum | 1 |
| Total Distillate, volume % | 1% above maximum or below minimum | 1 |
| Solubility, % | 0.01% below minimum | 1 |

**703.03.04 Emulsified Asphalts.** Emulsified asphalts shall conform to the requirements herein.

When tolerances are expressed in terms of percent, the allowable deviation is calculated as the indicated percentage at the upper or lower specification limit, whichever is applicable.

Tests will be performed within 14 days from the date sampled.

Emulsions may be required to be diluted with water to the percentages of 70 and 30, 60 and 40, or 50 and 50 by mass. The values are specified as %Emulsion and %Added Water of the diluted mixture.

## CATIONIC EMULSIFIED ASPHALTS

| TEST | TEST METHOD | Slow Setting | | Medium Setting | TOLERANCE |
|---|---|---|---|---|---|
| | | CSS-1 | CSS-1h | CMS-2s | |
| **Tests on Emulsion:** | | | | | |
| Saybolt Furol Viscosity @ 25 °C (77 °F), sec | Nev. T759 | 20-100 | 20-100 | — | None |
| Saybolt Furol Viscosity @ 50 °C (122 °F), sec | Nev. T759 | — | — | 50-450 | None |
| Residue, % | Nev. T759 | 57 Min. | 57 Min. | 60 Min. | 1.0 |
| Storage Stability, 24 hr, % | Nev. T759 | 1 Max. | 1 Max. | 1 Max. | 0.5 |
| Sieve, % | Nev. T759 | 0.10 Max. | 0.10 Max. | 0.10 Max. | 0.03 |
| Cement Mixing, % | Nev. T759 | 2.0 Max. | 2.0 Max. | — | 0.2 |
| Particle Charge | Nev. T759 | Pass | Pass | — | None |
| pH | AASHTO T200 | — | — | 2.0-5.0 | None |
| Oil Distillate, % by volume | Nev. T759 | — | — | 5.0-15.0 | None |
| **Tests on Residue from Distillation:** | | | | | |
| Penetration @ 25 °C (77 °F), 100 g, 5 sec | Nev. T759 | 100-250 | 40-90 | 100-250 | 7.0% |
| Solubility, % | AASHTO T44 | 97.5 Min. | 97.5 Min. | 97.5 Min. | 0.10 |
| Ductility @ 25 °C (77 °F), 5 cm/min, cm | AASHTO T51 | 40 Min. | 40 Min. | — | 10% |
| **Tests on Diluted Emulsion:** | | | | | |
| Residue, %, 70% and 30% | Nev. T759 | 40 Min. | 40 Min. | — | 1.0 |
| Residue, %, 60% and 40% | Nev. T759 | 34 Min. | 34 Min. | — | 1.0 |
| Residue, %, 50% and 50% | Nev. T759 | 29 Min. | 29 Min. | 30 Min. | 1.0 |

## CATIONIC EMULSIFIED ASPHALTS

| TEST | TEST METHOD | Rapid Setting | Quick Setting | | TOLERANCE |
|---|---|---|---|---|---|
| | | CRS-2nv | CQS-1nv | CQS-1h | |
| **Tests on Emulsion:** | | | | | |
| Saybolt Furol Viscosity @ 25 °C (77 °F), sec | Nev. T759 | — | 20-100 | 20-100 | None |
| Saybolt Furol Viscosity @ 50 °C (122 °F), sec | Nev. T759 | 150-450 | — | — | None |
| Residue, % | Nev. T759 | 65 Min. | 57 Min. | 57 Min. | 1.0 |
| Storage Stability, 24 hr, % | Nev. T759 | 1 Max. | — | — | 0.5 |
| Demulsibility, % | Nev. T759 | 40 Min. | — | — | 5% |
| Sieve, % | Nev. T759 | 0.10 Max. | 0.10 Max. | 0.10 Max. | 0.03 |
| Cement Mixing, % | Nev. T759 | — | 25 Min. (a) | — | None |
| Particle Charge | Nev. T759 | Pass | Pass | Pass | None |
| Oil Distillate, % by volume | Nev. T759 | 3 Max. | — | — | None |
| **Tests on Residue from Distillation:** | | | | | |
| Penetration @ 25 °C (77 °F), 100 g, 5 sec | Nev. T759 | 60-100 | 40-90 | 40-90 | 7.0% |
| Solubility, % | AASHTO T44 | 97.5 Min. | 97.5 Min. | 97.5 Min. | 0.10 |
| Ductility @ 25 °C (77 °F), 5 cm/min, cm | AASHTO T51 | 40 Min. | 40 Min. | 40 Min. | 10% |
| **Tests on Diluted Emulsion:** | | | | | |
| Residue, %, 70% and 30% | Nev. T759 | — | 40 Min. | 40 Min. | 1.0 |
| Residue, %, 60% and 40% | Nev. T759 | — | 34 Min. | 34 Min. | 1.0 |
| Residue, %, 50% and 50% | Nev. T759 | — | 29 Min. | 29 Min. | 1.0 |

(a) If the amount of breakage is significant enough to impede the flow of water through the testing screen, thus making it impossible to calculate a result, the test will be considered passing.

Cationic emulsified asphalts not conforming to the requirements specified herein will be assessed demerits according to the following schedule.

| TEST | INCREMENT | DEMERITS |
|---|---|---|
| Saybolt Viscosity, CSS-1, CSS-1h, CQS-1nv, CQS-1h | 2 seconds above maximum | 1 |
| Saybolt Viscosity, CSS-1, CSS-1h, CQS-1nv, CQS-1h | Below minimum | 10 |
| Saybolt Viscosity, CRS-2nv | 2 seconds above maximum or below minimum | 1 |
| Saybolt Viscosity, CMS-2s | 2 seconds above maximum or below minimum to 20 seconds | 1 |
| Saybolt Viscosity, CMS-2s | Below 20 seconds | 21 |
| Residue, % | 1 % below minimum | 2 |
| Demulsilbility, % | 1 % below minimum | 2 |
| Sieve, % | 0.1 % above maximum | 1 |
| Cement Mixing, %, CSS-1, CSS-1h | 0.5 % above maximum | 1 |
| Cement Mixing, %, CQS-1nv | Below minimum | 21 |
| Particle Charge | Fail | 21 |
| Oil Distillate, % | 0.25 % above maximum or below minimum | 2 |
| Penetration | 0.1 mm above maximum or below minimum | 1 |
| Solubility, % | 0.01 % below minimum | 1 |

## ANIONIC EMULSIFIED ASPHALTS

| TEST | TEST METHOD | SLOW SETTING | | TOLERANCE |
|---|---|---|---|---|
| | | SS-1 | SS-1h | |
| **Tests on Emulsion:** | | | | |
| Saybolt Furol Viscosity @ 25 °C (77 °F), sec | Nev. T759 | 20-100 | 20-100 | None |
| Residue, % | Nev. T759 | 57 Min. | 57 Min. | 1.0 |
| Storage Stability, 24 hr, % | Nev. T759 | 1 Max. | 1 Max. | 0.5 |
| Sieve, % | Nev. T759 | 0.10 Max. | 0.10 Max. | 0.03 |
| Cement Mixing, % | Nev. T759 | 2.0 Max. | 2.0 Max. | 0.2 |
| **Tests on Residue from Distillation:** | | | | |
| Penetration @ 25 °C (77 °F), 100 g, 5 sec | Nev. T759 | 100-200 | 40-90 | 7.0% |
| Solubility, % | AASHTO T44 | 97.5 Min. | 97.5 Min. | 0.10 |
| Ductility @ 25 °C (77 °F), 5 cm/min, cm | AASHTO T51 | 40 Min. | 40 Min. | 10% |
| **Tests on Diluted Emulsion:** | | | | |
| Residue, %, 70% and 30% | Nev. T759 | 40 Min. | 40 Min. | 1.0 |
| Residue, %, 60% and 40% | Nev. T759 | 34 Min. | 34 Min. | 1.0 |
| Residue, %, 50% and 50% | Nev. T759 | 29 Min. | 29 Min. | 1.0 |

Anionic emulsified asphalts not conforming to the requirements specified herein will be assessed demerits according to the following schedule.

| TEST | INCREMENT | DEMERITS |
|---|---|---|
| Saybolt Viscosity | 2 seconds above maximum | 1 |
| Saybolt Viscosity | Below minimum | 10 |
| Residue, % | 1 % below minimum | 2 |
| Sieve, % | 0.1 % above maximum | 1 |
| Cement Mixing, % | 0.5 % above maximum | 1 |
| Penetration | 0.1 mm above maximum or below minimum | 1 |
| Solubility,% | 0.01 % below minimum | 1 |

## LATEX MODIFIED RAPID SETTING EMULSIFIED ASPHALT

| TEST | TEST METHOD | LMCRS-2h | TOLERANCE |
|---|---|---|---|
| **Tests on Emulsion:** | | | |
| Saybolt Furol Viscosity @ 50 °C (122 °F), sec | Nev. T759 | 150-450 | None |
| Residue, % | Nev. T759 | 65 Min. | 1.0 |
| Storage Stability, 24 hr, % | Nev. T759 | 1 Max. | 0.5 |
| Demulsibility, % | Nev. T759 | 40 Min. | 5% |
| Sieve, % | Nev. T759 | 0.30 Max. | 0.03 |
| Particle Charge | Nev. T759 | Pass | None |
| **Tests on Residue from Evaporation:** | | | |
| Penetration @ 25 °C (77 °F), 100 g, 5 sec | Nev. T759 | 40-90 | 7% |
| Torsional Recovery, % | Nev. T757 | 22 Min. | None |
| Ductility @ 25 °C (77 °F), 5 cm/min, cm | AASHTO T51 | 40 Min. | 10% |

Latex modified emulsified asphalt not conforming to the requirements specified herein will be assessed demerits according to the following schedule.

| TEST | INCREMENT | DEMERITS |
|---|---|---|
| Saybolt Viscosity | 2 seconds above maximum or below minimum | 1 |
| Residue, % | 1% below minimum | 2 |
| Demulsibility, % | 1% below minimum | 2 |
| Sieve, % | 0.1% above maximum | 1 |
| Particle Charge | Fail | 21 |
| Penetration | 0.1 mm above maximum or below minimum | 1 |
| Torsional Recovery, % | 1% below minimum | 1 |

## MICRO-SURFACING EMULSION

| TEST | TEST METHOD | MSE | MSE-h | TOLERANCE |
|---|---|---|---|---|
| **Tests on Emulsion:** | | | | |
| Saybolt Furol Viscosity @ 25 °C (77 °F), sec | Nev. T759 | 20-100 | 20-100 | None |
| Residue, % | Nev. T759 | 64 Min. | 64 Min. | 1.0 |
| Storage Stability, 24 hr, % | Nev. T759 | 1 Max. | 1 Max. | 0.5 |
| Sieve, % | Nev. T759 | 0.30 Max. | 0.30 Max. | 0.03 |
| Particle Charge | Nev. T759 | Pass | Pass | None |
| Polymer Content, % by mass of residual asphalt | (a) | 3.5 Min. | 3.5 Min. | None |
| **Tests on Residue from Evaporation:** | | | | |
| Penetration @ 25 °C (77 °F), 100g, 5 sec | Nev. T759 | 40-90 | — | 7% |
| Penetration @ 25 °C (77 °F), 100g, 5 sec | Nev. T759 | — | 35-55 | None |
| Softening Point, °C (°F) | AASHTO T53 | 60 (140) Min. | 60 (140) Min. | None |
| Torsional Recovery, % | Nev. T757 | 25 Min. | 25 Min. | None |
| Ductility @ 25 °C (77 °F), 5 cm/min, cm | AASHTO T51 | 60 Min. | 60 Min. | 10% |

(a) Certificates of compliance provided for the material shall certify that the minimum polymer content is present.

Micro-surfacing emulsion not conforming to the requirements specified herein will be assessed demerits according to the following schedule.

| TEST | INCREMENT | DEMERITS |
|---|---|---|
| Saybolt Viscosity | 2 seconds above maximum | 1 |
| Saybolt Viscosity | Below minimum | 10 |
| Residue, % | 1% below minimum | 4 |
| Sieve, % | 0.1% above maximum | 1 |
| Particle Charge | Fail | 21 |
| Penetration | 0.1 mm above maximum or below minimum | 1 |
| Softening Point | 0.5 °C (1 °F) below minimum | 2 |
| Torsional Recovery, % | 1% below minimum | 2 |

## POLYMER MODIFIED PAVEMENT SEALANTS

| TEST | TEST METHOD | PMPS | PMPS-h | PMPS-QB | PMPS-FS | TOLERANCE |
|---|---|---|---|---|---|---|
| **Tests on Emulsion:** | | | | | | |
| Saybolt Furol Viscosity @ 50 °C (122 °F), sec | Nev. T759 | 50-350 | 120-450 | — | 20-100 | None |
| Saybolt Furol Viscosity @ 25 °C (77 °F), sec | Nev. T759 | — | — | 20-100 | — | None |
| Residue, % | Nev. T759 | 65 Min. | 65 Min. | 65 Min. | 64 Min. | 1.0 |
| pH | AASHTO T200 | 2.0–5.0 | 2.0–5.0 | 2.0–5.0 | — | None |
| Sieve, % | Nev. T759 | 0.1 Max. | 0.1 Max. | 0.1 Max. | 0.30 Max. | 0.03 |
| Oil Distillate, % (a) | Nev. T759 | 0.5 Max. | 0.5 Max. | 0.5 Max. | — | None |
| Particle Charge | Nev. T759 | — | — | — | Pass | None |
| **Tests on Residue from Evaporation:** | | | | | | |
| Viscosity @ 60 °C, Pa•s (140 °F, Poises) | AASHTO T202 | 500 Max. (5000 Max.) | 500 Max. (5000 Max.) | 500 Max. (5000 Max.) | — | 7.0% |
| Penetration @ 4 °C (39.2 °F), 200 g, 60 sec | Nev. T759 | 40 Min. | 10-70 | 35 Min. | — | 7.0% |
| Softening Point, °C (°F) | AASHTO T53 | — | — | — | 54.5 Min. (130 Min.) | 1 °C (2 °F) |
| Elastic Recovery @ 25 °C (77 °F), % | AASHTO T301 | — | 40 Min. | — | 45 Min. | None |
| Elastic Recovery @ 4 °C (39.2 °F), % | AASHTO T301 | 45 Min. | — | 45 Min. | — | None |
| Ductility @ 25 °C (77 °F), 5 cm/min, cm | AASHTO T51 | — | — | — | 100 Min. | 20% |
| **Tests on Diluted Emulsions:** | | | | | | |
| Residue, %, 70% and 30% | Nev. T759 | — | — | 46 Min. | — | 1.0 |
| Residue, %, 60% and 40% | Nev. T759 | — | — | 39 Min. | 38 Min. | 1.0 |
| Residue, %, 50% and 50% | Nev. T759 | — | — | 33 Min. | 32 Min. | 1.0 |
| **Tests on Latex:** | | | | | | |
| Specific Gravity | ASTM D1475 | 1.08-1.15 | 1.08-1.15 | 1.08-1.15 | — | None |
| Tensile Strength, die C dumbbell, psi (b) | ASTM D412 | 500 Min. | 500 Min. | 500 Min. | — | None |
| Swelling in rejuvenating agent, %, 48 hour exposure @ 104 °F | Nev. T747 | 40% Max. intact film | 40% Max. intact film | 40% Max. intact film | — | None |
| **Tests on Rejuvenating Agent:** | | | | | | |
| Kinematic Viscosity @ 60 °C, $mm^2/s$ (140 °F, cSt) | AASHTO T201 | 50-175 (50-175) | 50-175 (50-175) | 50-175 (50-175) | — | 2% |
| Flash Point, °C (°F) | AASHTO T48 | 193 Min. (380 Min.) | 193 Min. (380 Min.) | 193 Min. (380 Min.) | — | 8 °C (15 °F) |
| Saturate, % | ASTM D2007 | 30 Max. | 30 Max. | 30 Max. | — | None |
| Asphaltenes, % | ASTM D2007 | 1.0 Max. | 1.0 Max. | 1.0 Max. | — | None |
| Weight Change, % | AASHTO T240 | 6.5 Max. | 6.5 Max. | 6.5 Max. | — | None |
| Viscosity Ratio | AASHTO T240 | 3.0 Max. | 3.0 Max. | 3.0 Max. | — | None |

(a) Reduce the temperature on the lower thermometer to 177 ± 5 °C (350 ± 10 °F) and maintain this temperature for 20 minutes.
(b) Samples for tensile strength in accordance with ASTM D412 shall be cut using a die dumbbell at a crosshead speed of 20 cm/min.

Polymer modified pavements sealants not conforming to the requirements specified herein will be assessed demerits according to the following schedule.

| TEST | INCREMENT | DEMERITS |
|---|---|---|
| Saybolt Viscosity, PMPS | 2 seconds above maximum or below minimum to 20 seconds | 1 |
| Saybolt Viscosity, PMPS | Below 20 seconds | 21 |
| Saybolt Viscosity, PMPS-h | 2 seconds above maximum or below minimum | 1 |
| Saybolt Viscosity, PMPS-QB, PMPS-FS | 2 seconds above maximum | 1 |
| Saybolt Viscosity, PMPS-QB, PMPS-FS | Below minimum | 10 |
| Residue, % | 1% below minimum | 2 |
| Sieve, % | 0.1 above maximum | 1 |
| Oil Distillate, % | 0.25% above maximum | 2 |
| Particle Charge | Fail | 21 |
| Viscosity | 3.2 Pa·s (32 Poises) above maximum | 1 |
| Penetration | 0.1 mm above maximum or below minimum | 1 |
| Softening Point | 0.5 °C (1 °F) below minimum | 1 |
| Elastic Recovery, % | 1% below minimum | 1 |

# SECTION 704

## BASE AGGREGATES

### SCOPE

**704.01.01 Materials Covered.** This specification covers the quality and size of mineral materials used in base courses.

### REQUIREMENTS

**704.02.01 General.** Produce mineral aggregate from approved deposits. The use of aggregates from any source may be prohibited when:

(a) The character of the material is such, in the opinion of the Engineer, as to make improbable the furnishing of aggregates conforming to the requirements of these specifications.

(b) That character of the material is such, in the opinion of the Engineer, that undue additional costs may be accrued by the State.

The mineral aggregate shall be clean, hard, durable, free from frozen lumps, deleterious matter, and harmful adherent coatings.

**704.02.02 Deficiencies.** If the product of a deposit is deficient in material passing the 4.75 mm (No. 4) sieve, filler from other approved deposits may be added at the crushing and screening plants.

**704.02.03 Plastic Limits.** When specified, aggregates shall conform to the applicable requirements of the following table:

**TABLE I**

| Percent Passing by Mass* 75 µm (No. 200) Sieve | Plasticity Index Maximum |
|---|---|
| 0-3 | 15 |
| 4 | 12 |
| 5 | 9 |
| 6-8 | 6 |
| 9-11 | 4 |
| 12-15 | 3 |

*Test Method No. Nev. T206.

### PHYSICAL PROPERTIES AND TESTS

**704.03.01 Drain Backfill.** This aggregate shall conform to one of the following requirements:

| | Percent Passing by Mass | | |
|---|---|---|---|
| **Sieve Size** | **Type 1** | **Type 2** | **Type 3** |
| 50 mm (2 in.) | 100 | — | — |
| 37.5 mm (1 1/2 in.) | 90-100 | — | — |
| 25 mm (1 in.) | — | 100 | — |
| 19 mm (3/4 in.) | 50-80 | 90-100 | — |
| 9.5 mm (3/8 in.) | — | 20-55 | 100 |
| 4.75 mm (No. 4) | 24-40 | 0-10 | 60-90 |
| 1.18 mm (No. 16) | 10-24 | — | 26-60 |
| 150 µm (No. 100) | 0-4 | 0-4 | 0-4 |
| 75 µm (No. 200) | 0-2 | 0-2 | 0-2 |

| Project Control Tests | Test Method | Requirements |
|---|---|---|
| Sieve Analysis | Nev. T206 | Above |
| Sampling Aggregate | Nev. T200 | — |

| Source Requirement Tests | Test Method | Requirements |
|---|---|---|
| Percentage of Wear (500 Rev.) | AASHTO T96 | 37% Max. |

Unless otherwise specified in the contract documents, either Type 1, 2, or 3 may be used.

**704.03.02 Type 1 Class A Aggregate Base.** This aggregate shall conform to the following requirements:

| Sieve Size | Percent Passing by Mass |
|---|---|
| 37.5 mm (1 1/2 in.) | 100 |
| 25 mm (1 in.) | 80-100 |
| 4.75 mm (No. 4) | 30-65 |
| 1.18 mm (No. 16) | 15-40 |
| 75 μm (No. 200) | 2-12 |

| Project Control Tests | Test Method | Requirements |
|---|---|---|
| Sieve Analysis | Nev. T206 | Above |
| Sampling Aggregate | Nev. T200 | — |
| Fractured Faces | Nev. T230 | 35% Min. |
| Plasticity Index | Nev. T212 | Table I |
| Liquid Limit | Nev. T210 | 35 Max. |

| Source Requirement Tests | Test Method | Requirements |
|---|---|---|
| Resistance (R Value) | Nev. T115 | 70 Min. |
| Percentage of Wear (500 Rev.) | AASHTO T96 | 45% Max. |

**704.03.03 Type 1 Class B Aggregate Base.** This aggregate shall conform to the following requirements:

| Sieve Size | Percent Passing by Mass |
|---|---|
| 37.5 mm (1 1/2 in.) | 100 |
| 25 mm (1 in.) | 80-100 |
| 4.75 mm (No. 4) | 30-65 |
| 1.18 mm (No. 16) | 15-40 |
| 75 μm (No. 200) | 2-12 |

| Project Control Tests | Test Method | Requirements |
|---|---|---|
| Sieve Analysis | Nev. T206 | Above |
| Sampling Aggregate | Nev. T200 | — |
| Fractured Faces | Nev. T230 | 15% Min. |
| Plasticity Index | Nev. T212 | Table I |
| Liquid Limit | Nev. T210 | 35 Max. |

| Source Requirement Tests | Test Method | Requirements |
|---|---|---|
| Resistance (R Value) | Nev. T115 | 70 Min. |
| Percentage of Wear (500 Rev.) | AASHTO T96 | 45% Max. |

**704.03.04 Type 2 Class A Aggregate Base.** This aggregate shall conform to the following requirements:

| Sieve Size | Percent Passing by Mass |
|---|---|
| 25 mm (1 in.) | 100 |
| 19 mm (3/4 in.) | 90-100 |
| 4.75 mm (No. 4) | 35-65 |
| 1.18 mm (No. 16) | 15-40 |
| 75 μm (No. 200) | 2-10 |

| Project Control Tests | Test Method | Requirements |
|---|---|---|
| Sieve Analysis | Nev. T206 | Above |
| Sampling Aggregate | Nev. T200 | — |
| Fractured Faces | Nev. T230 | 50% Min. |
| Plasticity Index | Nev. T212 | Table I |
| Liquid Limit | Nev. T210 | 35 Max. |

| Source Requirement Tests | Test Method | Requirements |
|---|---|---|
| Resistance (R Value) | Nev. T115 | 78 Min. |
| Percentage of Wear (500 Rev.) | AASHTO T96 | 45% Max. |

**704.03.05 Type 2 Class B Aggregate Base.** This aggregate shall conform to the following requirements:

| Sieve Size | Percent Passing by Mass |
|---|---|
| 25 mm (1 in.) | 100 |
| 19 mm (3/4 in.) | 90-100 |
| 4.75 mm (No. 4) | 35-65 |
| 1.18 mm (No. 16) | 15-40 |
| 75 μm (No. 200) | 2-10 |

| Project Control Tests | Test Method | Requirements |
|---|---|---|
| Sieve Analysis | Nev. T206 | Above |
| Sampling Aggregate | Nev. T200 | — |
| Fractured Faces | Nev. T230 | 35% Min. |
| Plasticity Index | Nev. T212 | Table I |
| Liquid Limit | Nev. T210 | 35 Max. |

| Source Requirement Tests | Test Method | Requirements |
|---|---|---|
| Resistance (R Value) | Nev. T115 | 70 Min. |
| Percentage of Wear (500 Rev.) | AASHTO T96 | 45% Max. |

**704.03.06 Type 3 Class A Aggregate Base.** All requirements will be specified in the Special Provisions.

**704.03.07 Type 3 Class B Aggregate Base.** All requirements will be specified in the Special Provisions.

**704.03.08 Aggregate for Portland Cement Treated Base.** This aggregate shall conform to the following requirements:

| Sieve Size | Percent Passing by Mass |
|---|---|
| 25 mm (1 in.) | 100 |
| 19 mm (3/4 in.) | 90-100 |
| 4.75 mm (No. 4) | 35-75 |
| 1.18 mm (No. 16) | 15-45 |
| 75 μm (No. 200) | 2-15 |

| Project Control Tests | Test Method | Requirements |
|---|---|---|
| Sieve Analysis | Nev. T206 | Above |
| Sampling Aggregate | Nev. T200 | — |
| Sand Equivalent | Nev. T227 | 20% Min. |

| Source Requirement Tests | Test Method | Requirements |
|---|---|---|
| Percentage of Wear (500 Rev.) | AASHTO T96 | 45% Max. |

**704.03.09 Shouldering Material.** This aggregate shall conform to the following requirements:

| Sieve Size | Percent Passing by Mass |
|---|---|
| 37 mm (1 1/2 in.) | 100 |
| 25 mm (1 in.) | 80-100 |
| 4.75 mm (No. 4) | 30-65 |
| 1.18 mm (No. 16) | 15-40 |
| 75 μm (No. 200) | 2-12 |

| Project Control Tests | Test Method | Requirements |
|---|---|---|
| Sieve Analysis | Nev. T206 | Above |
| Sampling Aggregate | Nev. T200 | — |
| Plasticity Index | Nev. T212 | 12 Max. |

**704.03.10 Backfill.** Acceptable material from excavation may be used for backfilling unless granular backfill is specified and the material from excavation does not conform to the requirements therefore.

The material shall conform to the following requirements:

| Sieve Size | Percent Passing by Mass |
|---|---|
| 75 mm (3 in.) | 100 |

| Project Control Tests | Test Method | Requirements |
|---|---|---|
| Sieve Analysis | Nev. T206 | Above |
| Sampling Aggregate | Nev. T200 | — |

**704.03.11 Granular Backfill.** Granular backfill shall consist of natural sand or a mixture of sand with gravel, crushed gravel, or crushed stone and shall conform to the following requirements:

| Sieve Size | Percent Passing by Mass |
|---|---|
| 75 mm (3 in.) | 100 |
| 4.75 mm (No. 4) | 35-100 |
| 600 µm (No. 30) | 20-100 |
| 75 µm (No. 200) | 0-12 |

| Project Control Tests | Test Method | Requirements |
|---|---|---|
| Sieve Analysis | Nev. T206 | Above |
| Sampling Aggregate | Nev. T200 | — |
| Liquid Limit | Nev. T210 | 35 Max. |
| Plasticity Index | Nev. T212 | 10 Max. |

Granular backfill shall also conform to the following requirements based on usage:

| Source Requirement Tests | Test Method | Culverts and Structures (Concrete) Culverts (Aluminum and Plastic) Requirements | Culverts (Steel) Requirements |
|---|---|---|---|
| pH Value | AASHTO T289 | 5.0 to 9.5 | 6.0 to 9.0. |
| Resistivity | AASHTO T288 | 1000 ohm·cm Min. | 2000 ohm·cm Min. |

Do not use pea gravel as granular backfill. Pea gravel is typically a byproduct of aggregate crushing and/or screening operations. It is uniformly graded, normally having a nominal size of 9.5 mm (3/8 in.)

Cold millings will not be allowed for use as granular backfill.

**704.03.12 Borrow.** The material shall conform to the following requirements:

| Source Requirement Tests | Test Method | Requirements |
|---|---|---|
| Resistance (R Value) | Nev. T115 | 45 Min. |

**704.03.13 Selected Borrow.** The material shall conform to the following requirements:

| Sieve Size | Percent Passing by Mass |
|---|---|
| 75 mm (3 in.) | 100 |

| Project Control Tests | Test Method | Requirements |
|---|---|---|
| Sieve Analysis | Nev. T206 | Above |
| Sampling Aggregate | Nev. T200 | — |

| Source Requirement Tests | Test Method | Requirements |
|---|---|---|
| Resistance (R Value) | Nev. T115 | 45 Min. |

# SECTION 705

## AGGREGATES FOR BITUMINOUS COURSES

### SCOPE

**705.01.01 Materials Covered.** This specification covers the quality and size of local mineral materials and commercial mineral fillers used in bituminous courses.

### REQUIREMENTS

**705.02.01 General.** Provide mineral aggregate from approved deposits. The use of aggregates from any source may be prohibited when:

(a) The character of the material is such, in the opinion of the Engineer, as to make improbable the furnishing of aggregates conforming to the requirements of these specifications.

(b) The character of the material is such, in the opinion of the Engineer, that undue additional costs may be accrued by the State.

The mineral aggregate shall be clean, hard, durable, free from frozen lumps, deleterious matter, and harmful adherent coatings. Crush and incorporate material between the sizes of the 250 mm (10 in.) in largest dimension and larger than the maximum size specified for a given product, into that specified finished product. Do not produce other products simultaneously by “bleeding off” aggregates.

When Type 2C plantmix aggregate is specified for dense-graded plantmix, produce Type 2C and Open-Graded plantmix aggregates by screening all natural fines passing the 9.5 mm (3/8 in.) sieve from the coarse aggregate. Such fines may be reintroduced into the mix at a rate not to exceed 10% by dry mass of the combined aggregates. Stockpile such fines separately from other sizes of aggregate. Use natural fines only when all applicable mix design criteria have been met.

**705.02.02 Deficiencies.** If the product of any deposit is deficient in the fraction passing the 4.75 mm (No. 4) sieve, additional filler from other approved deposits meeting the physical requirements may be added. Add the additional material to the drier in a uniform manner from a separate stockpile. If the added material is a commercial mineral filler, uniformly feed it directly to the plant. Do not construe this as a waiver of any of the requirements contained herein.

### PHYSICAL PROPERTIES AND TESTS

**705.03.01 Plantmix Bituminous Surface Aggregates.** The aggregate shall conform to the following requirements:

| | Percent Passing by Mass | | |
|---|---|---|---|
| **Sieve Size** | **Type 2** | **Type 2C** | **Type 3** |
| 25 mm (1 in.) | 100 | 100 | — |
| 19 mm (3/4 in.) | 90-100 | 88-95 | — |
| 12.5 mm (1/2 in.) | — | 70-85 | 100 |
| 9.5 mm (3/8 in.) | 63-85 | 60-78 | 85-100 |
| 4.75 mm (No. 4) | 45-63 | 43-60 | 50-75 |
| 2 mm (No. 10) | 30-44 | 30-44 | 32-52 |
| 1.18 mm (No. 16) | — | — | — |
| 425 µm (No. 40) | 12-22 | 12-22 | 12-26 |
| 75 µm (No. 200) | 3-8 | 3-8 | 3-8 |

| PROJECT CONTROL TESTS | TEST METHOD | REQUIREMENTS |
|---|---|---|
| Sieve Analysis | Nev. T206 | Above |
| Sampling Aggregate | Nev. T200 | — |
| Fractured Faces (Type 3 Plantmix Aggregate) | Nev. T230 | 35% Min., 1 Fracture Min. (a) |
| Fractured Faces (Type 2 or 2C Plantmix Aggregate) | Nev. T230 | 80% Min., 2 Fractures Min. (a) |
| Plasticity Index (Blending with sand to eliminate plasticity will not be permitted) | Nev. T212 | 10 Max. (a) |
| Liquid Limit | Nev. T210 | 35 Max. (a) |
| Absorption of Coarse Aggregate | Nev. T111 | 4% Max. (a) |

(a) Individual stockpiles before marination.

| MIX DESIGN TESTS | TEST METHOD | REQUIREMENTS |
|---|---|---|
| Sieve Analysis | Nev. T206 | Above |
| Sampling Aggregate | Nev. T200 | — |
| Fractured Faces (Type 3 Plantmix Aggregate) | Nev. T230 | 35% Min., 1 Fracture Min. (b) |
| Fractured Faces (Type 2 or 2C Plantmix Aggregate) | Nev. T230 | 80% Min., 2 Fractures Min. (b) |
| Plasticity Index (Blending with sand to eliminate plasticity will not be permitted) | Nev. T212 | 10 Max. (a) |
| Liquid Limit | Nev. T210 | 35 Max. (a) |
| Absorption of Coarse Aggregate | Nev. T111 | 4% Max. (b) |

(a) Individual stockpiles before marination.
(b) Individual stockpiles.

| SOURCE REQUIREMENT TESTS | TEST METHOD | REQUIREMENTS |
|---|---|---|
| Percentage of Wear (500 Rev.) | AASHTO T96 | 37% Max. |
| Soundness (Coarse Aggregate) (5 Cycles, Sodium Sulfate) | AASHTO T104 | 12% Max. Loss |
| Soundness (Fine Aggregate) (5 Cycles, Sodium Sulfate) | AASHTO T104 | 15% Max. Loss |
| Absorption of Coarse Aggregate | Nev. T111 | 4% Max. |
| Specific Gravity (Fine Aggregate) | Nev. T493 | 2.95 Max. |
| Specific Gravity (Coarse Aggregate) | Nev. T111 | 2.95 Max. |

**705.03.02 Plantmix Bituminous Open-Graded Surface Aggregate.** The aggregate shall conform to the following requirements:

| | Percent Passing by Mass | |
|---|---|---|
| **Sieve Size** | **12.5 mm (1/2 in.) Size** | **9.5 mm (3/8 in.) Size** |
| 12.5 mm (1/2 in.) | 100 | 100 |
| 9.5 mm (3/8 in.) | 90-100 | 95-100 |
| 4.75 mm (No. 4) | 35-55 | 40-65 |
| 1.18 mm (No. 16) | 5-18 | 12-22 |
| 75 μm (No. 200) | 0-4 | 0-5 |

| PROJECT CONTROL TESTS | TEST METHOD | REQUIREMENTS |
|---|---|---|
| Sieve Analysis | Nev. T206 | Above |
| Sampling Aggregate | Nev. T200 | — |
| Fractured Faces | Nev. T230 | 90% Min., 2 Fractures Min. (a) |
| Plasticity Index (Blending with sand to eliminate plasticity will not be permitted) | Nev. T212 | 10 Max. (a) |
| Liquid Limit | Nev. T210 | 35 Max. (a) |
| Absorption of Coarse Aggregate | Nev. T111 | 4% Max. (a) |

(a) Individual stockpiles before marination.

| MIX DESIGN TESTS | TEST METHOD | REQUIREMENTS |
|---|---|---|
| Sieve Analysis | Nev. T206 | Above |
| Sampling Aggregate | Nev. T200 | — |
| Fractured Faces | Nev. T230 | 90% Min., 2 Fractures Min. (b) |
| Plasticity Index (Blending with sand to eliminate plasticity will not be permitted) | Nev. T212 | 10 Max. (a) |
| Liquid Limit | Nev. T210 | 35 Max. (a) |
| Absorption of Coarse Aggregate | Nev. T111 | 4% Max. (b) |

(a) Individual stockpiles before marination.
(b) Individual stockpiles.

| SOURCE REQUIREMENT TESTS | TEST METHOD | REQUIREMENTS |
|---|---|---|
| Percentage of Wear (500 Rev.) | AASHTO T96 | 37% Max. |
| Soundness (Coarse Aggregate) (5 Cycles, Sodium Sulfate) | AASHTO T104 | 12% Max. Loss |
| Soundness (Fine Aggregate) (5 Cycles, Sodium Sulfate) | AASHTO T104 | 15% Max. Loss |
| Absorption of Coarse Aggregate | Nev. T111 | 4% Max. |
| Specific Gravity (Fine Aggregate) | Nev. T493 | 2.95 Max. |
| Specific Gravity (Coarse Aggregate) | Nev. T111 | 2.95 Max. |

**705.03.03 Commercial Mineral Filler.** Commercial mineral filler shall be hydrated lime conforming to ASTM C1097.

**705.03.04 Screenings.** The screenings shall conform to the following requirements:

| | Percent Passing by Mass | | |
|---|---|---|---|
| | 12.5 mm (1/2 in.) Size | | 9.5 mm (3/8 in.) Size |
| Sieve Size | Grade 1 | Grade 2 | |
| 12.5 mm (1/2 in.) | 100 | 100 | — |
| 9.5 mm (3/8 in.) | 90-100 | 50-80 | 100 |
| 4.75 mm (No. 4) | 15-35 | 0-15 | 20-45 |
| 2.36 mm (No. 8) | — | 0-5 | — |
| 1.18 mm (No. 16) | 0-4 | — | 0-6 |
| 75 µm (No. 200) | 0-2 | 0-2 | 0-2 |

| Project Control Tests | Test Method | Requirements |
|---|---|---|
| Sieve Analysis | Nev. T206 | Above |
| Sampling Aggregate | Nev. T200 | — |
| Fractured Faces | Nev. T230 | 90% Min. (2 Fractures Min.) |
| Cleanness Value | Nev. T228 | 81% Min. |
| Stripping Test | Nev. T209 | Satisfactory |

| Source Requirement Tests | Test Method | Requirements |
|---|---|---|
| Percentage of Wear (500 Rev.) | AASHTO T96 | 37% Max. |

**705.03.05 Sand Blotter.** The sand shall conform to the following requirements:

| Sieve Size | Percent Passing by Mass |
|---|---|
| 12.5 mm (1/2 in.) | 100 |
| 4.75 mm (No. 4) | 90-100 |
| 1.18 mm (No. 16) | 30-75 |
| 75 µm (No. 200) | 0-12 |

| Project Control Tests | Test Method | Requirements |
|---|---|---|
| Sieve Analysis | Nev. T206 | Above |
| Sampling Aggregate | Nev. T200 | — |

**705.03.06 Micro-Surfacing Aggregate.** The aggregate shall conform to the following requirements:

| | Percent Passing by Mass | |
|---|---|---|
| Sieve Size | Type II | Type III |
| 9.5 mm (3/8 in.) | 100 | 100 |
| 4.75 mm (No. 4) | 90-100 | 70-90 |
| 2.36 mm (No. 8) | 65-90 | 45-70 |
| 1.18 mm (No. 16) | 45-70 | 28-50 |
| 600 µm (No. 30) | 30-50 | 19-34 |
| 300 µm (No. 50) | 18-30 | 12-25 |
| 150 µm (No. 100) | 10-21 | 7-18 |
| 75 µm (No. 200) | 5-15 | 5-15 |

| PROJECT CONTROL TESTS | TEST METHOD | REQUIREMENTS |
|---|---|---|
| Sieve Analysis | Nev. T206 | Above |
| Sampling Aggregate | Nev. T200 | — |
| Fractured Faces | Nev. T230 | 90% Min., 2 Fracture Min. (a) |
| Plasticity Index (Blending with sand to eliminate plasticity will not be permitted) | Nev. T212 | 3 Max. |
| Liquid Limit | Nev. T210 | 35 Max. |
| Sand Equivalent | Nev. T227 | 65 Min. |

(a) Individual stockpiles.

| MIX DESIGN TESTS | TEST METHOD | REQUIREMENTS |
|---|---|---|
| Sieve Analysis | Nev. T206 | Above |
| Sampling Aggregate | Nev. T200 | — |
| Fractured Faces | Nev. T230 | 90% Min., 2 Fracture Min. (a) |
| Plasticity Index (Blending with sand to eliminate plasticity will not be permitted) | Nev. T212 | 3 Max. |
| Liquid Limit | Nev. T210 | 35 Max. |
| Sand Equivalent | Nev. T227 | 65 Min. |
| Percentage of Wear (500 Rev.) | AASHTO T96 | 30% Max. (b) |
| Soundness (Coarse Aggregate) (5 Cycles, Sodium Sulfate) | AASHTO T104 | 12% Max. Loss |
| Soundness (Fine Aggregate) (5 Cycles, Sodium Sulfate) | AASHTO T104 | 15% Max. Loss |

(a) Individual stockpiles.
(b) The test is to be run on the aggregate before it is crushed.

| SOURCE REQUIREMENT TESTS | TEST METHOD | REQUIREMENTS |
|---|---|---|
| Percentage of Wear (500 Rev.) | AASHTO T96 | 30% Max. (a) |
| Soundness (Coarse Aggregate) (5 Cycles, Sodium Sulfate) | AASHTO T104 | 12% Max. Loss |
| Soundness (Fine Aggregate) (5 Cycles, Sodium Sulfate) | AASHTO T104 | 15% Max. Loss |

(a) The test is to be run on the aggregate before it is crushed.

# SECTION 706

## AGGREGATES FOR PORTLAND CEMENT PRODUCTS

### SCOPE

**706.01.01 Materials Covered.** This specification covers the quality and size of aggregates used in Portland cement products.

### REQUIREMENTS

**706.02.01 General.** The mineral aggregate shall be the product of approved deposits. Aggregates from any source having a history of alkali-silica reactivity in concrete will not be approved for use. The use of aggregates from any source may be prohibited when:

(a) The character of the material is such, in the opinion of the Engineer, as to make improbable the furnishing of aggregates conforming to the requirements of these specifications.

(b) The character of the material is such, in the opinion of the Engineer, that undue additional costs may be accrued by the State.

For mix design approval, the proposed proportions of individual aggregates, combined mathematically, by volume or mass, shall produce a mixture within the grading limits for combined aggregates as shown in the following table (not applicable to lightweight concrete):

**GRADING LIMITS OF COMBINED AGGREGATES**

| SIEVE SIZE | PERCENT PASSING BY MASS | | | | |
|---|---|---|---|---|---|
| | **37.5 mm (1 1/2 in.)** | **25 mm (1 in.)** | **19 mm (3/4 in.)** | **12.5 mm (1/2 in.)** | **9.5 mm (3/8 in.)** |
| 50 mm (2 in.) | 100 | — | — | — | — |
| 37.5 mm (1 1/2 in.) | 87-100 | 100 | — | — | — |
| 25 mm (1 in.) | 65-90 | 97-100 | 100 | — | — |
| 19 mm (3/4 in.) | 48-82 | 70-100 | 80-100 | 100 | — |
| 12.5 mm (1/2 in.) | — | — | — | 90-100 | 100 |
| 9.5 mm (3/8 in.) | 39-57 | 43-70 | 46-70 | 70-90 | 70-100 |
| 4.75 mm (No. 4) | 30-45 | 32-48 | 34-50 | 45-60 | 47-70 |
| 2.36 mm (No. 8) | 23-38 | 23-42 | 24-42 | 38-56 | 34-55 |
| 1.18 mm (No. 16) | 15-33 | 15-34 | 17-34 | 24-38 | 23-43 |
| 600 μm (No. 30) | 8-24 | 8-25 | 10-25 | 13-27 | 15-33 |
| 300 μm (No. 50) | 4-13 | 4-15 | 5-15 | 7-17 | 7-20 |
| 150 μm (No. 100) | 1-5 | 2-7 | 2-7 | 0-6 | 2-8 |
| 75 μm (No. 200) | 0-3 | 0-3 | 0-3 | 0-3 | 0-3 |

If changing the source of supply of aggregates, submit in writing the new gradations before their intended use.

In addition to the aggregates meeting the individual source requirements, the combined gradation shall meet the following source requirement:

| TEST | TEST METHOD | REQUIREMENT |
|---|---|---|
| Accelerated Detection of Potentially Deleterious Expansion of Mortar Bars Due to Alkali-Silica Reaction | AASHTO T303 | 0.10% Max. Expansion |

Previous AASHTO T303 qualified aggregates for concrete mix designs will not automatically qualify for approval. Submit new AASHTO T303 test results with concrete mix design.

Perform AASHTO T303 testing on the combined aggregates in the same proportions as the proposed mix design. The test may be performed on each size separately and the results combined mathematically. Perform the test using the proposed sources together with cement and mineral admixtures from the proposed mix design. The mineral admixture quantities will be considered as cement in meeting the requirements of cement in Table I of Subsection 501.02.05.

Perform AASHTO T303 testing on material proposed for use in an approved laboratory. Give notification prior to obtaining samples of all materials for this test so that split samples may be obtained for verification testing. Submit a certified copy of the AASHTO T303 test results, together with proposed mix design for approval, at least 30 days prior to intended use. If more than one mix design is submitted, additional time may be required for approval.

Prior to mix design approval, the Department reserves the right to verify the AASHTO T303 test results, using the sources and proportions of materials as indicated by the mix design.

Conduct another AASHTO T303 test upon changes in source of aggregate, cement, or mineral admixtures.

PHYSICAL PROPERTIES AND TESTS

**706.03.01 Coarse Aggregate.** This aggregate shall conform to the following requirements:

| SIEVE SIZE | PERCENT PASSING BY MASS | | | | | |
|---|---|---|---|---|---|---|
| | Size No. 4 | Size No. 7 | Size No. 8 | Size No. 57 | Size No. 67 | Size No. 89 |
| 50 mm (2 in.) | 100 | — | — | — | — | — |
| 37.5 mm (1 1/2 in.) | 90-100 | — | — | 100 | — | — |
| 25 mm (1 in.) | 20-55 | — | — | 95-100 | 100 | — |
| 19 mm (3/4 in.) | 0-15 | 100 | — | — | 90-100 | — |
| 12.5 mm (1/2 in.) | — | 90-100 | 100 | 25-60 | — | 100 |
| 9.5 mm (3/8 in.) | 0-5 | 40-70 | 85-100 | — | 20-55 | 90-100 |
| 4.75 mm (No. 4) | — | 0-15 | 10-30 | 0-10 | 0-10 | 20-55 |
| 2.36 mm (No. 8) | — | 0-5 | 0-10 | 0-5 | 0-5 | 5-30 |
| 1.18 mm (No. 16) | — | — | 0-5 | — | — | 0-10 |
| 300 µm (No. 50) | — | — | — | — | — | 0-5 |

Thin or elongated aggregate pieces (length greater than five times the minimum thickness) shall not exceed 15% by mass.

| PROJECT CONTROL TEST | TEST METHOD | REQUIREMENTS |
|---|---|---|
| Sieve Analysis | Nev. T206 | Above |
| Sampling Aggregate | Nev. T200 | — |
| Material Passing 75 µm (No. 200) Sieve | Nev. T206 | 1% Max. |
| Cleanness Value | Nev. T228 | 71 Min. * |
| Clay Lumps | AASHTO T112 | 0.3% Max. |

* Individual stockpiles.

| SOURCE REQUIREMENT TEST | TEST METHOD | REQUIREMENTS |
|---|---|---|
| Percentage of Wear, 500 Rev. | AASHTO T96 | 50% Max. |
| Soundness, 5 cycles, Sodium Sulfate | AASHTO T104 | 12% Max. Loss |

**706.03.02 Lightweight Aggregate.** This aggregate shall conform to the following requirements:

| SIEVE SIZE | PERCENT PASSING BY MASS | | | |
|---|---|---|---|---|
| | Fine Natural | Fine Lightweight | 25 mm (1 in.) Size Coarse | 19 mm (3/4 in.) Size Coarse |
| 25 mm (1 in.) | — | — | 95-100 | 100 |
| 19 mm (3/4 in.) | — | — | — | 90-100 |
| 12.5 mm (1/2 in.) | — | — | 25-60 | — |
| 9.5 mm (3/8 in.) | 100 | 100 | — | 20-60 |
| 4.75 mm (No. 4) | 95-100 | 85-100 | 0-10 | 0-10 |
| 1.18 mm (No. 16) | 45-80 | 40-80 | — | — |
| 300 μm (No. 50) | 10-35 | 10-35 | — | — |
| 150 μm (No. 100) | 2-12 | 5-25 | — | — |
| 75 μm (No. 200) | 0-5 | — | — | — |

| PROJECT CONTROL TEST | TEST METHOD | REQUIREMENTS |
|---|---|---|
| Sieve Analysis | Nev. T206 | Above (a) |
| Sampling | Nev. T200 | — |
| Clay Lumps | AASHTO T112 | 2% Max. |

| SOURCE REQUIREMENT TEST | TEST METHOD | REQUIREMENTS |
|---|---|---|
| Unit Weight (Loose oven dry) | AASHTO T19 | Fine Aggregate: 1121 kg/m$^3$ (70 lb/ft$^3$) Max. (b), Coarse Aggregate: 881 kg/m$^3$ (55 lb/ft$^3$) Max. (b), Combined Fine and Coarse: 1041 kg/m$^3$ (65 lb/ft$^3$) Max. (b) |
| Organic Impurities | AASHTO T21 | Satisfactory (c) |
| Test for Staining Materials | ASTM C330 | Satisfactory (d) |
| Mortar Making Properties | ASTM C87 | 95% Min. (e) |

(a) Exceptions. The mass of the test sample for the fine lightweight aggregate shall be according to Table III, and the aggregate when mechanically sieved shall be sieved for only 5 minutes. The test sample for coarse aggregate shall consist of not less than 6 kg (13 lb) of the material used for the determination of unit mass.

**TABLE III**

| MASS OF SIEVE TEST SAMPLE FOR FINE LIGHTWEIGHT AGGREGATES | |
|---|---|
| NOMINAL MASS OF AGGREGATE kg/m$^3$ (lb/ft$^3$) | MASS OF TEST SAMPLE grams |
| 400-560 (25-35) | 150 |
| 560-720 (35-45) | 200 |
| 720-880 (45-55) | 250 |
| 880-1040 (55-65) | 300 |
| 1040-1120 (65-70) | 350 |

(b) The unit mass of successive shipments of lightweight aggregate shall not differ by more than 10% from that of the sample submitted for acceptance tests.

(c) Aggregates tested and showing color darker than the standard shall be rejected unless it can be demonstrated that the discoloration is due to small quantities of materials not harmful to the concrete.

(d) Aggregates tested and showing stain darker than “heavy stain” (stain index of 80 or darker) shall be tested by chemical procedure, and aggregates that contain 1.5 mg or more of ferric oxide ($Fe_2O_3$) per 200 g sample shall be rejected for use.

(e) Fine aggregate failing in the test for organic impurities (AASHTO T21) may be used provided that when tested for effect of organic impurities on strength of mortar, the relative strength at 7 and 28 days calculated according to ASTM C87 is not less than 95%.

**706.03.03 Fine Aggregate.** This aggregate shall conform to the following requirements:

| Sieve Size | Percent Passing by Mass |
|---|---|
| 9.5 mm (3/8 in.) | 100 |
| 4.75 mm (No. 4) | 95-100 |
| 2.36 mm (No. 8) | 80-100 |
| 1.18 mm (No. 16) | 50-85 |
| 600 μm (No. 30) | 25-60 |
| 300 μm (No. 50) | 5-30 |
| 150 μm (No. 100) | 0-10 |
| 75 μm (No. 200) | 0-5 |

| PROJECT CONTROL TEST | TEST METHOD | REQUIREMENTS |
|---|---|---|
| Sieve Analysis | Nev. T206 | Above |
| Sampling Aggregate | Nev. T200 | — |
| Sand Equivalent | Nev. T227 | 71 Min. |
| Clay Lumps | AASHTO T112 | 1% Max. |

| SOURCE REQUIREMENT TEST | TEST METHOD | REQUIREMENTS |
|---|---|---|
| Soundness (5 cycles, Sodium Sulfate) | AASHTO T104 | 10% Max. Loss |
| Lightweight Pieces in Aggregate with less than 1.95 Sp. Gr. | AASHTO T113 | 1% Max. |
| Organic Impurities | AASHTO T21 | Satisfactory (a) |
| Mortar Making Properties | ASTM C87 | 95% Min. (b) |
| Fineness Modulus | AASHTO T27 and AASHTO T11 | 2.30 – 3.10 |

(a) Aggregates tested and showing color darker than the standard shall be rejected unless they pass the “Mortar Making Properties” test (ASTM C87).

(b) This test shall only be required should samples of fine aggregate fail to pass the organic impurities test. Fine aggregate failing in the test for organic impurities (AASHTO T21) may be used provided that when tested for effect of organic impurities on strength of mortar, the relative strength at 7 and 28 days calculated according to ASTM C87 is not less than 95%.

**706.03.04 Grout and Mortar Aggregate.** Aggregate for grout and mortar shall conform to either of the following requirements:

| Sieve Size | Percent Passing by Mass |
|---|---|
| 9.5 mm (3/8 in.) | 100 |
| 4.75 mm (No. 4) | 95-100 |
| 1.18 mm (No. 16) | 45-80 |
| 300 μm (No. 50) | 10-35 |
| 150 μm (No. 100) | 2-12 |
| 75 μm (No. 200) | 0-5 |

| Sieve Size | Percent Passing by Mass * |
|---|---|
| 4.75 mm (No. 4) | 100 |
| 2.36 mm (No. 8) | 95-100 |
| 1.18 mm (No. 16) | 70-100 |
| 600 μm (No. 30) | 40-75 |
| 300 μm (No. 50) | 20-50 |
| 150 μm (No. 100) | 10-25 |
| 75 μm (No. 200) | 0-10 |

* When lightweight, natural, or manufactured aggregate fails the gradation limits specified above, it may be used provided the mortar can be prepared to comply with the aggregate ratio, water retention, and compressive strength requirements of the property specification of ASTM C270 for mortar for unit masonry.

Coarse aggregate for grout shall conform to either of the following requirements:

| Sieve Size | Percent Passing by Mass Size No. 8 | Size No. 89 |
|---|---|---|
| 12.5 mm (1/2 in.) | 100 | 100 |
| 9.5 mm (3/8 in.) | 85-100 | 90-100 |
| 4.75 mm (No. 4) | 10-30 | 20-55 |
| 2.36 mm (No. 8) | 0-10 | 5-30 |
| 1.18 mm (No. 16) | 0-5 | 0-10 |
| 600 μm (No. 30) | — | 0-5 |

| PROJECT CONTROL TEST | TEST METHOD | REQUIREMENTS |
|---|---|---|
| Sieve Analysis | Nev. T206 | Above |
| Sampling Aggregate | Nev. T200 | — |

| SOURCE REQUIREMENT TEST | TEST METHOD | REQUIREMENTS |
|---|---|---|
| Organic Impurities | AASHTO T21 | Satisfactory (a) |
| Soundness, Coarse Aggregate, 5 Cycles, Sodium Sulfate | AASHTO T104 | 12% Max. Loss |
| Soundness, Fine Aggregate, 5 Cycles, Sodium Sulfate | AASHTO T104 | 10% Max. Loss |
| Mortar Making Properties | ASTM C87 | 95% Min. (b) |

(a) Aggregates tested and showing color darker than the standard shall be rejected unless they pass the “Mortar Making Properties” test (ASTM C87).

(b) This test will only be required should samples of sand fail to pass the “Organic Impurities” test (AASHTO T21). Sand failing in the test for organic impurities may be used provided that when tested for effect of organic impurities on mortar strength, the relative strength at 7 and 28 days calculated according to ASTM C87 is not less than 95%.

# SECTION 707

## JOINT MATERIAL

SCOPE

**707.01.01 Material Covered.** This specification covers the quality requirements for poured filler, preformed fillers, and resilient and rubber type gaskets.

PHYSICAL PROPERTIES AND TESTS

**707.03.01 Joint Fillers**. Preformed fillers for joints shall conform to the requirements of ASTM D1751, Fiber Type. Punch fillers to admit the dowels where called for on the plans. Furnish the filler for each joint in a single piece for the full depth and width required for the joint unless otherwise authorized. When the use of more than one piece is authorized for a joint, fasten the abutting ends securely and hold in place by stapling or other positive satisfactory fastening.

**707.03.02 Tongue and Groove Joints and Gasketed Joints.** Tongue and groove joints for reinforced concrete pipes, precast reinforced concrete box culverts, and precast manhole sections shall use butyl rubber sealant and shall conform to ASTM C990 or shall use elastomeric seals conforming to ASTM C1619.

Gasketed joints for reinforced concrete pipes and manhole sections shall conform to ASTM C443.

Gasketed joints for precast reinforced concrete box culverts shall conform to ASTM C1677.

Store sealants and gaskets in a clean place at 21 °C (70 °F) or less. Do not expose sealants or gaskets to the direct rays of the sun for more than 72 hours.

**707.03.03 Waterstops.** Waterstops shall conform to the requirements specified herein.

(a) Natural Rubber.

| TEST | TEST METHOD | REQUIREMENT |
|---|---|---|
| Tension Testing of Vulcanized Rubber | ASTM D412 | Tensile strength 24 MPa (3,500 psi) Min., elongation at breaking of 550%.<br>Unit stress (300%) 8 MPa (1,100 psi) Min.<br>Unit stress (500%) 20 MPa (2,800 psi) Min. |
| Test for Accelerated Aging of Vulcanized Rubber by the Oxygen Pressure Method | ASTM D572 | After 7 days in air at 66 ± 1 °C (150 ± 2 °F) or after 48 hours in oxygen at 70 ± 1 °C (158 ± 2 °F) and 2 MPa (300 psi), the tensile strength and elongation shall not be less than 65% of the original. |
| Test for Indentation of Rubber by Means of a Durometer | ASTM D2240 | 55 to 65 (hardness) |

Manufacture natural rubber waterstops from a stock composed of a high grade compound made exclusively from new plantation rubber reinforced carbon black, zinc oxide, accelerators, antioxidants, and softeners. This compound shall contain not less than 72% by volume of new plantation rubber.

(b) Synthetic Rubber.

| TEST | TEST METHOD | REQUIREMENT |
|---|---|---|
| Tension Testing of Vulcanized Rubber | ASTM D412 | Tensile strength 18 MPa (2,500 psi) Min., elongation at breaking of 420% |
| Test for Accelerated Aging of Vulcanized Rubber by the Oxygen Pressure Method | ASTM D572 | After 7 days in air at 70 ± 1 °C (158 ± 2 °F) or after 48 hours in oxygen at 70 ± 1 °C (158 ± 2 °F) and 2 MPa (300 psi), the tensile strength and elongation shall not be less than 65% of the original |
| Test for Indentation of Rubber by Means of a Durometer | ASTM D2240 | 50 to 70 (hardness) |

(c) Polyvinyl Chloride.

| TEST | TEST METHOD | REQUIREMENT |
|---|---|---|
| Polyvinyl Chloride Waterstops | Corps of Engineers CRD-C572 | Compliance of paragraph 6 |

**707.03.04 Joint Sealer for Weakened Plane Joints in Portland Cement Concrete Pavements.** Use joint sealants listed in the QPL.

Place all sealants according to the manufacturer's recommendations. Furnish 2 copies of the manufacturer's recommendations not less than 14 days in advance of beginning joint sealing operations.

**707.03.05 Preformed Elastomeric Joint Seals.** Preformed elastomeric joint seals shall conform to ASTM D3542. The seals shall consist of a multiple-web design, function only by compression between the faces of the joint, allow for movement of the bridge, and seal the joint against admission of moisture. The minimum nominal depth of the seal shall be at least 95% of the uncompressed width. The movement rating of each seal, as determined by ASTM D3542, shall be not less than the movement rating as shown on the plans.

# SECTION 708

## CONCRETE AND PLASTIC PIPE

SCOPE

**708.01.01 Materials Covered.** This specification covers the quality of reinforced concrete pipe, clay pipe, and plastic pipe.

PHYSICAL PROPERTIES AND TESTS

**708.03.01 Reinforced Concrete Pipe.** This pipe shall conform to AASHTO M170 (AASHTO M207 for oval pipe) for the specified diameters and strength classes. Furnish oval pipe where specified. Unless otherwise specified, pipe wall design and use of elliptical reinforcement in circular pipe are optional.

Precast reinforced concrete end sections shall conform to the requirements of the cited specifications to the extent to which they apply.

**708.03.02 Perforated Concrete Pipe.** This pipe shall conform to AASHTO M175 or to ASTM C444 for the specified diameters and strength classes.

**708.03.03 Clay Pipe.** This pipe shall conform to ASTM C700 for pipe with full circular cross section, for the specified diameter and strength class. When specified, the bell shall have integral spacer lugs to provide for an annular opening and self-centering feature. Joints shall conform to ASTM C425.

**708.03.04 Plastic Pipe.** Perforated and nonperforated plastic pipe shall conform to the following for the sizes and the types specified in the contract. Joints shall be watertight and shall conform to ASTM D3212 or be fully welded in accordance with the manufacturer's specifications.

(a) Smooth Wall Polyethylene Pipe. Pipe shall conform to ASTM F714 and minimum cell class, ASTM D3350, 335434C. The standard dimensional ratio (SDR) of the pipe shall be a maximum of 26.

(b) Corrugated Polyethylene Pipe. Furnish pipe conforming to AASHTO M294, Type S or Type D.

Steel Reinforced Thermoplastic Ribbed Pipe conforming to ASTM F2562 and minimum cell class ASTM D3350, 345464C may be substituted for corrugated polyethylene pipe.

(c) Profile Wall (Ribbed) Polyethylene Pipe. Pipe shall conform to ASTM F894 and minimum cell class, ASTM D3350, 334433C or 335434C.

(d) Corrugated Polyethylene Drainage Pipe. Pipe shall conform to AASHTO M252 and minimum cell class, ASTM D3350, 315412C.

(e) Smooth Wall Polyvinyl Chloride Pipe. Pipe shall conform to AASHTO M278 and minimum cell class, ASTM D1784, 12454C or 12364C.

(f) Profile Wall (ribbed) Polyvinyl Chloride Pipe. Pipe shall conform to AASHTO M304 and minimum cell class, ASTM D1784, 12454C or 12364C.

(g) Acrylonitrile-Butadiene-Styrene (ABS) Pipe. Pipe shall conform to AASHTO M264. When perforated pipe is specified, perforations shall conform to AASHTO M278.

# SECTION 709

## METAL PIPE AND DRAINS

SCOPE

**709.01.01 Material Covered.** This specification covers the quality of metal pipes, metal arch pipes, metal end sections, structural plate pipe, and perforated metal pipe.

PHYSICAL PROPERTIES AND TESTS

**709.03.01 Corrugated Steel Pipe.** These conduits and the coupling bands shall conform to AASHTO M36 for the specified sectional dimensions and galvanized coating. Furnish shop-formed elliptical pipe and shop strutted pipe where specified.

Special sections, such as elbows, tees, and wyes, for these conduits shall be of the same gage as the conduit to which they are joined, and shall conform to applicable requirements of AASHTO M36.

**709.03.02 Corrugated Aluminum Pipe.** This pipe shall conform to AASHTO M196.

**709.03.03 Anchor Assemblies for Downdrains.** Anchor assemblies, hardware, and accessories shall conform to the requirements of ASTM A153 and ASTM A123.

**709.03.04 Corrugated Steel Pipe for Underdrains.** This pipe shall conform to AASHTO M36, Type III for the specified diameters.

**709.03.05 Corrugated Aluminum Pipe for Underdrains.** This pipe shall conform to AASHTO M196 and M197.

**709.03.06 Steel Structural Plate Pipe and Pipe Arches.** This pipe shall conform to AASHTO M167.

**709.03.07 Aluminum Structural Plate Pipe and Pipe Arches.** This pipe shall conform to AASHTO M219.

# SECTION 710

## STRUCTURAL STEEL

SCOPE

**710.01.01 Material Covered.** This specification covers the quality of structural steel.

REQUIREMENTS

**710.02.01 Defects.** Finished rolled material shall be free from cracks, flaws, injurious seams, laps, blisters, ragged and imperfect edges, and other defects. It shall have a smooth, uniform finish and shall be straightened in the mill before shipment.

Provide material free from loose mill scale, rust pits, or other defects affecting its strength or durability.

Material will be rejected if deemed unsuitable for the purpose intended even though the material meets the requirements of the mill tolerances.

**710.02.02 Charpy V-notch Test.** Structural steel conforming to AASHTO M270 need not comply with the Impact Testing Requirements unless designated on the plans as main load carrying members subject to tensile stress. Structural steel requiring Impact Testing shall meet the minimum requirements of Zone 2, unless otherwise shown on the plans.

PHYSICAL PROPERTIES AND TESTS

**710.03.01 Standard Steel.** All steel for use in miscellaneous structures, unless otherwise noted, shall conform to AASHTO M270 Grade 250 (36).

**710.03.02 High Strength Low Alloy Columbium—Vanadium Steel.** This steel shall conform to AASHTO M270 Grade 345 (50), and shall be other than rimmed or capped steel.

**710.03.03 High Strength Bolts.** All bolts, nuts, washers, and Tension Control Bolts used in high-strength connections shall conform to Article 11.3.2 of the AASHTO LRFD Bridge Construction Specifications, except as follows:

1. All nuts used with AASHTO M164 or ASTM A325 type 1 bolts shall conform to the requirements of ASTM A563 Grade DH or ASTM A194 Grade 2H. All nuts used with AASHTO M164 or ASTM A325 type 3 bolts shall conform to the requirements of ASTM A563 Grade DH3.

2. Tension Control Bolts shall be considered Alternative Fasteners as defined in Article 11.3.2.5 of the AASHTO LRFD Bridge Construction Specifications, and shall meet the requirements contained therein.

3. The Rotational Capacity Test will be performed on all bolt, nut, and washer assemblies as outlined in Article 11.5.6.4.2 of the AASHTO LRFD Bridge Construction Specifications and shall meet the requirements therein.

**710.03.04 Stainless Steel Bolts.** This steel shall conform to ASTM A276.

**710.03.05 Welded Seamless Steel Pipe.** This steel shall conform to ASTM A53, Type S, Grade B.

**710.03.06 Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.** This steel shall conform to ASTM A500, Grade B.

**710.03.07 Shear Stud Connectors.** Shear stud connectors shall conform to Article 6.4.4 of the AASHTO LRFD Bridge Design Specifications.

**710.03.08 Pins and Rollers.** This steel shall conform to Article 6.4.2 of the AASHTO LRFD Bridge Design Specifications, except pin nuts shall conform to Subsection 710.03.01.

**710.03.09 Bolts.** All bolts, nuts, and washers not intended for high-strength connections shall conform to ASTM A307.

**710.03.10 Structural Steel.** Unless otherwise noted on the plans, all structural steel for use in main load carrying members of bridge structures shall conform to AASHTO M270, Grade 345 (50). Bridge elements typically not considered as main load carrying members include: crossframes, diaphragms, wind bracing, stiffeners, gussett plates, bearing plates, and expansion assemblies.

**710.03.11 High Strength Low Alloy Steel.** This steel shall conform to AASHTO M270.

**710.03.12 High-Yield-Strength, Quenched and Tempered Alloy Steel Plate, Suitable for Welding.** This steel shall conform to AASHTO M270.

**710.03.13 High-Yield-Strength Alloy Steel Plates, Quenched and Tempered for Pressure Vessels.** This steel shall conform to ASTM A517.

# SECTION 712

## MISCELLANEOUS METAL

SCOPE

**712.01.01 Material Covered.** This specification covers the type and quality of miscellaneous metals.

PHYSICAL PROPERTIES AND TESTS

**712.03.01 Steel Castings.** This steel shall conform to ASTM A27, Grade 450-240 (Grade 65-35).

**712.03.02 Gray Iron Castings.** These castings shall conform to ASTM A48, Class 275 (Class 40).

**712.03.03 Malleable Castings.** These castings shall conform to ASTM A47, Grade 22010 (Grade 32510).

**712.03.04 Aluminum for Bridge Rail.** Aluminum bridge rail shall conform to the following requirements:

(a) Aluminum Alloy for Pipe. This pipe shall conform to ASTM B241 Alloy 6061-T6 or 6063-T6.

(b) Aluminum Alloy Tubing. This tubing shall conform to ASTM B221 Alloy 6061-T6 or 6063-T6.

(c) Cast Aluminum Alloy. This alloy shall conform to AASHTO M193.

(d) Aluminum Alloy Shims. This alloy shall conform to ASTM B209 Alloy 1100-0.

**712.03.05 Bronze Castings.** These castings shall conform to ASTM B22, Copper Alloy No. 863 (UNS No. C86300).

**712.03.06 Welding Materials.** Materials used for welding miscellaneous metals shall conform to AWS D1.1/D1.1M.

**712.03.07 Steel Piles.** This steel (“H” Piles and Sheet Piling) shall conform to ASTM A36.

**712.03.08 Steel for Pipe Piles.** This steel shall conform to ASTM A252, Grade 2.

# SECTION 713

## REINFORCEMENT

### SCOPE

**713.01.01 Materials Covered.** This specification covers the quality of bar steel, welded wire reinforcement, and prestressing steel.

### PHYSICAL PROPERTIES AND TESTS

**713.03.01 Bar Steel Reinforcement.** This steel shall conform to the applicable following requirements:

| | |
|---|---|
| Deformed Billet-Steel Bars for Concrete Reinforcement | AASHTO M31, Grade 300 (40) or 420 (60) |
| Low Alloy Steel Deformed and Plain Bars for Concrete Reinforcement | ASTM A706 |
| Spiral/Welded Hoop Reinforcement | ASTM A706 |

Unless specified otherwise, use reinforcement conforming to AASHTO M31 or ASTM A706. Reinforcing steel bars for longitudinal bars in columns and for welded applications shall conform to ASTM A706. Generally, reinforcement bars for minor structures, sign and signal foundations, and concrete barrier rails may conform to AASHTO M31.

Spiral or hoop reinforcement in columns and piles may be furnished deformed or plain.

Reinforcing steel bars failing to meet the minimum unit stress when calculated on the basis of AASHTO M31 or ASTM A706 may be considered acceptable if minimum specification requirements are satisfied by computing the “Section Area” method described in Test Method No. Nev. T484.

Furnish 3 copies of certified mill test results for each heat of steel supplied to the project. Additionally furnish two 750 mm (30 in.) samples of each size per heat for testing. Field samples may also be tested from “extra” bars as required in Subsection 505.02.02.

**713.03.02 Welded Wire Reinforcement.** This steel shall conform to ASTM A1064.

**713.03.03 Prestressing Steel.** Prestressing steel shall be high tensile wire conforming to AASHTO M204, including all supplementary requirements; high tensile seven wire strand conforming to AASHTO M203; or uncoated high-strength steel bars conforming to AASHTO M275, including all supplementary requirements. The maximum mass requirement of AASHTO M275 will not apply.

In addition to the requirements of AASHTO M275, for deformed bars, the reduction of area shall be determined from a bar from which the deformations have been removed. The bar shall be machined no more than necessary to remove the deformations over a length of 300 mm (12 in.), and reduction will be based on the area of the machined portion.

Use the same grade bars in any individual member, unless otherwise permitted.

When bars are to be extended by the use of couplers, the assembled units shall have a tensile strength of not less than the manufacturer’s minimum guaranteed ultimate tensile strength of the bars. Failure of any one sample to meet this requirement will be cause for rejection of the heat of bars and lot of couplers. Place couplers at approved locations.

Straighten wires if necessary to produce equal stress in all wires or wire groups or parallel lay cables that are to be stressed simultaneously or when necessary to insure proper positioning in the ducts.

Sampling and testing shall conform to AASHTO M203 and AASHTO M204 and as specified below.

Assign all bars of each size from each mill heat, all wire from each coil, and all strand from each manufactured reel to be shipped to the site an individual lot number and tag in such a manner that each such lot can be accurately identified at the jobsite. Likewise identify each lot of anchorage assemblies and bar couplers to be installed at the site. Submit records identifying assigned lot numbers with the heat, or reel of material represented. All unidentified prestressing steel, anchorage assemblies or bar couplers received at the site will be rejected.

Furnish samples for testing from each size and each heat of prestressing bars, from each manufactured reel of prestressing steel strand, from each coil of prestressing wire, and from each lot of anchorage assemblies and bar couplers to be used. Submit with each sample of prestressing steel wires, bars, or strands furnished for testing, a certification stating the manufacturer's minimum guaranteed ultimate tensile strength of the sample furnished.

No additional compensation will be given for any work delayed awaiting approval of the materials furnished for testing.

Furnish, at least 15 days in advance of anticipated use, the following samples of materials and tendons which will be selected from the prestressing steel at the plant or jobsite:

(a) For wire, strand, or bars, furnish 1.5 m (5 ft) long samples of each size for each heat and pack or reel.

(b) If the prestressing tendon is to be prefabricated, furnish one completely fabricated prestressing tendon 1.5 m (5 ft) in length for each size of tendon, including anchorage assemblies. If the prestressing tendon is to be assembled at the jobsite, furnish sufficient wire or strand and end fittings to make up one complete prestressing tendon 1.5 m (5 ft) in length for each size of tendon, including anchorage assemblies.

(c) If the prestressing tendon is a bar, furnish one 1.5 m (5 ft) length complete with one end anchorage and furnish in addition, if couplers are to be used with the bar, two 1.2 m (4 ft) lengths of bar equipped with one coupler and fabricated to fit the coupler.

For prefabricated tendons, give at least 14 days notice before commencing the installation of end fittings or the heading of wires. End fitting installations and wire headings will be inspected while such fabrication is in progress at the plant. The required testing will be arranged for the material to be shipped to the site.

Do not ship any prefabricated tendon to the site without first having been released by the Engineer, and tag each tendon before shipment for identification purposes at the site. All unidentified tendons received at the site will be rejected.

Consider jobsite or site as referred to herein to mean the location where the members are to be manufactured whether at the bridge site or a removed casting yard.

# SECTION 714

## PAINT

SCOPE

**714.01.01 Materials Covered.** This specification covers the quality, color, and number of applications of paint.

REQUIREMENTS

**714.02.01 Certificates.** Furnish written certification that all required tests have been satisfactorily completed and that the materials thereof comply with all the requirements. Supply paint samples to verify compliance when requested.

PHYSICAL PROPERTIES AND TESTS

**714.03.01 Paint for Iron and Steel.** (a) General. For use on structural steel used for bridge members, see paragraph (b) below.

Choose from Steel Structures Painting Council (SSPC) Alkyd Paint System 2.00 or Phenolic Paint System 3.00 when metal rail, bridge or pedestrian rail are specified to receive paint or when painting structural steel, miscellaneous iron and steel standards. The color of paint shall be as shown on the plans or specified in the Special Provisions. Do not use lead base paint.

Submit for approval a letter indicating choice of system, accompanied by certificates attesting that the products chosen meet the applicable specifications and requirements before application of any paint.

(b) Structural Steel Used for Bridge Members. Submit for approval a letter indicating choice of the complete coating system from one of the approved coating systems listed in the QPL.

The color of the paint shall be as shown on the plans or as specified in the Special Provisions.

Paint used for touch-up in the field or shop, shall be the same as used for the initial painting.

**714.03.02 Paint for Timber.** Use the following paints for cattle guard wings, bridge railings, sign posts, and miscellaneous timber structures.

| Purpose | Number of Coats | Color | General Type | Federal Specification |
|---|---|---|---|---|
| Prime | 1 | White | Mixed Pigment Exterior Wood Primer | TT-P-25 |
| Intermediate (first coat after primer) | 1 | Cream | Titanium Zinc Oxide | TT-P-102 Class B |
| Finish (second coat after primer) | 1 | White | Titanium Zinc Oxide | TT-P-102 Class B |
| Trim, Lettering and Indications (used when so indicated on plans) | 1 | Black | Titanium Zinc Oxide | TT-P-61 |

**714.03.03 Paint for Concrete.** Use the following paint for miscellaneous concrete specified to receive paint.

| Purpose | Number of Coats | Color | General Type | Formula or Specification |
|---|---|---|---|---|
| Finish | 1 | White | Water Thinned | Acrylic Resin or Synthetic Latex Alkyd Emulsion |

**714.03.04 Paint for Aluminum.** Prepare aluminum bridge railing and posts specified to receive paint by applying a chemical conversion coating conforming to MIL-C-5541. Apply the coating according to the manufacturer's specifications and recommended sequence of operations.

Any of the paint systems specified for use on iron or steel in Subsection 714.03.01 may be used for painting aluminum. Submit for approval a letter indicating choice of system as required for iron or steel.

# SECTION 715

## GALVANIZING

SCOPE

**715.01.01 Material Covered.** This specification covers the quality and thickness of galvanizing used on various material.

PHYSICAL PROPERTIES AND TESTS

**715.03.01 Iron and Steel Products 3 mm (1/8 in.) Thick and Thicker.** Galvanizing of products fabricated from rolled, pressed, and forged iron and steel shapes, castings, plates, bars, and strips shall conform to ASTM A123.

**715.03.02 Hardware.** Galvanizing of bolts, nuts, washers, and fastenings shall conform to ASTM A153.

**715.03.03 Mechanical Galvanizing.** In lieu of hot-dipped galvanizing as specified in these specifications, ferrous metals may be mechanically galvanized according to ASTM B695. Regardless of the method chosen, the coated product shall conform to the coating thickness, adherence, and quality requirements of AASHTO M232.

**715.03.04 Repair of Damaged Galvanizing.** Material and procedures for repair of damaged galvanizing shall conform to ASTM A780.

# SECTION 716

## SIGN MATERIALS

### SCOPE

**716.01.01 Materials Covered.** This specification covers the kind and quality of materials used in the construction and fabrication of signs.

### REQUIREMENTS

**716.02.01 Certificates.** Ascertain that all required tests have been made by approved testing laboratories as approved. Furnish a written certification that all required tests have been satisfactorily completed and that materials and fabrication thereof comply with all the requirements.

Receive approval of materials before use.

### PHYSICAL PROPERTIES AND TESTS

**716.03.01 Reflective Sheeting.** Reflective or retroreflective sheeting is classified as specified herein.

Use sheeting listed in the QPL.

(a) Type IV. The material shall conform to Type IV sheeting as specified in ASTM D4956.

(b) Type V. The material shall conform to Type V sheeting as specified in ASTM D4956.

(c) Type VI. The material shall conform to Type VI sheeting as specified in ASTM D4956.

(d) Type IX. The material shall conform to Type IX sheeting as specified in ASTM D4956.

(e) Type XI. The material shall conform to Type XI sheeting as specified in ASTM D4956.

**716.03.02 Fiberglass Reinforced Plastic Sign Panels.** Fiberglass Reinforced Plastic (FRP) for sign panels shall be a fiberglass reinforced thermoset polyester laminate. The panel shall be acrylic modified and U.V. stabilized for outdoor weatherability.

Fabricate sign blanks of a single piece of FRP unless otherwise specified. Cut FRP to proper sign blank size and provide bolt holes. Make edges, including holes, true and smooth.

The panel shall be stabilized to prevent the release of migrating constituents (i.e. solvent, monomers, etc.) over time and shall contain no residue agents on the surface so that neither migrating constituents nor release agents will be present in amounts that will interfere with any subsequent bonding operations.

Wipe the panel with a clean damp cloth and allow to dry completely before sheeting.

The panel shall not contain visible cracks, pinholes, foreign inclusions, or surface wrinkles that would affect implied performance, alter the specific dimensions of the panel, or otherwise affect its serviceability.

The panel shall conform to the following mechanical properties:

| Mechanical Property | Test Method | Averaged Minimum Requirements |
|---|---|---|
| Tensile Strength | ASTM D638 | 69 MPa (10,000 psi) |
| Tensile Modulus | ASTM D638 | 8,300 MPa (1,200,000 psi) |
| Flexural Strength | ASTM D790 | 138 MPa (20,000 psi) |
| Flexural Modulus | ASTM D790 | 8,300 MPa (1,200,000 psi) |
| Compression Strength | ASTM D695 | 220 MPa (32,000 psi) |
| Compression Modulus | ASTM D695 | 9,650 MPa (1,400,000 psi) |
| Punch Shear | ASTM D732 | 90 MPa (13,000 psi) |

The mechanical properties in the table above are measured in both the line direction of the panel and at 90° to the line as noted in the appropriate ASTM test referenced.

The panel shall conform to the following physical properties:

1. Thickness. Panels shall be 3.375 mm ± 0.125 mm (0.135 in. ± 0.005 in.) thick.

2. Size. Panel tolerance on nominal length and width shall be ± 3 mm (± 1/8 in.) for dimensions of 3.6 m (12 ft) or less when measured according to ASTM D3841.

3. Squareness. Panels shall be within 3 mm (1/8 in.) of square per 3.6 m (12 ft) of length when measured according to ASTM D3841.

4. Smoothness. Panels shall be manufactured with smooth surfaces on both faces of the panel.

5. Color. Panels shall be pigmented to a visually uniform gray color within the Munsel range of N.7.5/ to N.8.5/.

6. Coefficient of Linear Thermal Expansion. Panels shall have a maximum coefficient of linear thermal expansion of $3.24 \times 10^{-5}$ m/m/°C. ($1.8 \times 10^{-5}$ in./in./°F) when tested according to ASTM D696.

7. Weather Resistance. Panels shall be classified as to a minimum Grade II (weather resistant) panel as specified in ASTM D3841 following a 3,000 ± 100 hour weatherometer test.

8. Fire Resistance. The panels shall contain additives designed to be less responsive to fire ignition and flame propagation. The extent of burning shall not exceed 25 mm (1 in.) when tested according to ASTM D635.

9. Flatness. Panels shall have a maximum deflection of 12.5 mm (1/2 in.) when tested according to the following:

   The test requires five 750 mm by 750 mm (30 in. by 30 in.) FRP panels. Initial warpage is measured in 4 directions: 0°, 45°, 90° and 135°. To measure warpage, the panel is freely suspended at one corner, and a straight edge is placed along the panel so that the edges of the panel touch the straight edge. Care must be exercised so as not to disturb the dimensional characteristics of the panel. A rule graduated in mm (fractional inches) is used to measure the distance from the center of the panel face to the straight edge. That distance is measured to the nearest 1 mm (1/32 in.) in all four directions.

   The panels are then freely suspended diagonally in any oven for 48 hours at 82 °C (180 °F). After 48 hours in the oven, the panels are removed and allowed to cool to room temperature freely suspended. Warpage measurements and corresponding direction are again recorded as described above.

10. Impact Resistance. The panel shall resist the impact of a 0.535 kg (1.18 lb) falling ball dropped from 18 m (60 ft) according to ASTM D3841.

11. Thermal Stability. Panel strength and impact resistance shall not be appreciably affected over a temperature range of – 54 °C to 100 °C (– 65 °F to 212 °F).

**716.03.03 Aluminum Sign Panels.** Sheet aluminum for sign panels shall be of 2.0 mm (0.08 in.) aluminum alloy alclad 5052-H38 or 6061-T6 conforming to ASTM B209.

Fabricate sign panel sections of standard width aluminum sheets not less than 1.2 m (4 ft) wide, except that not more than 2 sheets for any one sign may be cut to less than 450 mm (18 in.) in width, so as to provide sign widths to nearest 150 mm (6 in.) increments. Panel sections shall run from the top edge to the bottom edge of the sign without horizontal joints.

Provide aluminum free of all corrosion, white rust, and dirt. All sign dimensions, metal gage, and bolt holes shall conform to the requirements set forth on the plans and in these specifications. Perform metal degreasing on all sheet aluminum by one of the following methods:

(a) Vapor Degreasing. Completely immerse signs in a saturated vapor of trichlorethylene or perchlorethylene. Remove trademark printing with lacquer thinner or a controlled alkaline cleaning system, and rinse thoroughly with running water.

(b) Alkaline Degreasing. Completely immerse signs in a tank containing alkaline solutions controlled and titrated to the solution manufacturer's specification. Immersion time shall depend upon the amount of soil to be removed. Then thoroughly rinse signs with running water.

Whenever reflective sheeting is required on the sign, etch the aluminum by one of the following methods:

(a) Acid Etch. Well-etch the aluminum in a 6 to 8% phosphoric acid solution at 38 °C (100 °F) and rinse thoroughly with running cold water, followed with a hot water tank rinse.

(b) Alkaline Etch. Etch well the precleaned aluminum in an alkaline etching material that is controlled by titration. Time, temperature, and concentration shall be as specified by the solution manufacturer. Remove smut with an acidic, chromium compound type solution as specified by the solution manufacturer and thoroughly rinse the sign.

The surface etch shall provide a clean, matte, nonshine or nonglare finish suitable for the application of paint or sheeting and for the unpainted back or reverse side.

After the degreasing and etching process, dry the aluminum by use of a forced air drier.

Do not handle metal, except by device or clean canvas gloves between cleaning operations and the application of the sign background material. Do not allow the aluminum to come in contact with greases, oils, or other contaminants before the application of the background material.

Accomplish fabrication of all metal parts in a uniform and workman-like manner. Complete all fabrication, including cutting, before the cleaning process. Cut metal panels to size and shape and keep free of buckles, warps, dents, cockles, burrs, and other defects resulting from fabrication. The surface of all sign panels shall be a plane surface.

**716.03.04 Overhead Sign Structures and Sign Frames.** The materials used in the fabrication of overhead sign structures and footings shall conform to the following requirements:

(a) Sign Frames. Bars, plates, and shapes shall be structural steel conforming to ASTM A36.

(b) Sign Pipe Posts. Pipe posts shall be welded or seamless steel pipe conforming to ASTM A53, Grade B. Posts may be fabricated from structural steel conforming to ASTM A36 or of ASTM A283, Grade D.

(c) Sign Steel Walkway Gratings. Furnish and install steel walkway gratings according to details shown on the plans and the following provisions:

1. Gratings shall be the standard product of an established grating manufacturer.

2. Material for gratings shall be structural steel conforming to ASTM A36.

3. For welded type gratings, resistance weld each joint welded under pressure to provide a sound, completely beaded joint.

4. For mechanically locked gratings, the method of fabrication and interlocking of the members shall be approved. The fabricated grating shall be equal in strength to the welded type.

5. After fabrication, hot-dip galvanize gratings.

6. Accurately fabricate gratings and keep free from warps, twists, or other defects affecting their appearance or serviceability. Make ends square on all rectangular panels. The tops of the bearing bars and cross members shall be in the same plane. Straighten gratings distorted by the galvanizing process.

(d) Bolts, Nuts, and Washers. High-strength steel bolts, nuts, and washers shall conform to Subsection 710.03.03. All other bolts and nuts, including anchor bolts and nuts for sign foundations, shall conform to ASTM A307, and furnish with commercial quality washers. Bolted connections shall conform to Subsection 506.03.07.

(e) Make bearing plates and gusset or stiffener plates of the sizes and dimensions shown on the plans and galvanize after fabrication. Steel shall conform to ASTM A36. Galvanizing shall conform to ASTM A123. All welding shall conform to the requirements set forth in Subsection 506.03.16.

(f) Anchor bolts, nuts, and washers shall be of structural carbon steel conforming to Section 710, and galvanized according to ASTM A153, or cadmium plated according to ASTM B766 Type TS. Galvanize or cadmium plate the top portion of anchor bolts to such extent that the galvanized or cadmium plated portion will extend at least 50 mm (2 in.) into concrete. Provide anchor bolts of the size, shape, and length as shown on the plans.

(g) Galvanize or cadmium plate all bolts, nuts, clamps, and metal washers unless otherwise noted. Cadmium plating shall conform to ASTM B766, minimum thickness as prescribed for grade Type TS, and galvanizing shall conform to ASTM A153.

(h) Manufacture supporting frames according to the plans and according to the requirements herein specified. Galvanize metal parts after fabrication, according to Section 715. When permission is granted to zinc coat a surface by means other than hot-dip galvanizing, use the metalizing process to place the zinc. Perform metalizing according to AWS Specifications. The thickness of the sprayed zinc coat shall be at least 125 µm (5 mils).

(i) Fabricate truss frames to the largest practical sections before galvanizing. Submit splice locations for approval and do not commence fabrication until such splice locations are approved.

(j) Perform fabrication and welding according to the requirements of this Subsection and Section 506 with the following exception; use AWS D1.1/D1.1M in lieu of AASHTO/AWS D1.5M/D1.5.

Give 15 day notification before the start of fabrication so inspection can be provided if necessary. Material not inspected at the fabrication shop will be subject to inspection in the field.

Before fabrication is started, submit 5 sets of shop drawings for each overhead sign structure for approval.

**716.03.05 Sign Hardware and Related Materials.** Make bearing, gusset, or stiffener plates of the sizes and dimensions shown on the plans and galvanize after fabrication. Steel shall conform to ASTM A36. Galvanizing shall conform to ASTM A123. Welding shall conform to Subsection 506.03.16.

Make bolts, nuts, clamps, and metal washers of structural, carbon steel conforming to Section 710 and galvanize according to ASTM A153, or cadmium plate according to ASTM B766, Type TS. Galvanize or cadmium plate the top portion of anchor bolts to such extent that the galvanized or cadmium plated portion will extend at least 50 mm (2 in.) into concrete. Provide anchor bolts of the size, shape, and length as shown on the plans.

Aluminum alloy tubular stiffeners shall be schedule 40 pipe fabricated of 6061-T6 aluminum alloy and shall conform to the specifications of ASTM B241.

Steel pipe for posts shall be welded or seamless steel pipe conforming to ASTM A53, Grade B, Standard Weight Class and shall be galvanized. Steel pipe posts shall be of the diameter and length shown on the plans. Fit the top of the posts with a cover.

Straps, bars, and braces used on single support signs shall be of aluminum alloy 6061-T6 and shall conform to ASTM B209.

Stringers for horizontal supporting structural members shall be of aluminum alloy 6061-T6 or 6062-T6 and shall conform to ASTM B308.

Cadmium plate bolts, nuts, clamps, and metal washers in contact with aluminum. Galvanize or cadmium plate all other bolts, nuts, clamps and metal washers. Cadmium plating shall conform to ASTM B766, with a minimum coating thickness as prescribed for grade Type TS and galvanizing shall conform to ASTM A153.

Construct wood posts and braces for sign supports of Douglas Fir, Western Hemlock, or any other equivalent stress rated wood material. Wood material shall be free-of-heart-center, have a minimum stress rating of 8.3 MPa (1,200 psi) for extreme fiber in bending, and shall be graded in accordance with Section 718. Sweep shall not exceed 25 mm (1 in.) in 3 m (10 ft). Pressure treat wood posts and braces according to Section 718.

Manufacture the expansion assembly for fastening the aluminum tubing to the aluminum Z-bars of a zinc die casting alloy which contains copper, aluminum, and magnesium. Cadmium plate the anchor bolt for the expansion assembly in conformance to ASTM B766, with a minimum coating thickness as prescribed for grade Type TS.

Square sign posts and anchors shall conform to the following requirements:

(a) Material. Steel posts shall conform to ASTM A653 or A1011. Steel posts shall have a minimum yield of 275 MPa (40,000 psi) after fabrication for the steel thicknesses indicated in the plans. Steel posts with a minimum yield of 415 MPa (60,000 psi) after fabrication may be substituted for the sizes and thicknesses shown in the plans according to the following table:

| Post Size | 275 MPa (40,000 psi) Steel Thickness | 415 MPa (60,000 psi) Steel Thickness |
|---|---|---|
| 64 mm (2 1/2 in.) | 10 gauge | 11 gauge |

(b) Shape. The cross section of the post shall be a square tube formed of steel carefully rolled to size and welded. The sign post anchor used with the 64 mm (2 1/2 in.) post shall be a square tube formed of 4.8 mm (3/16 in.) steel carefully rolled to size and welded.

(c) Fabrication. Furnish straight members with a smooth uniform finish. Provide holes and cut off ends which are free from burrs.

(d) Finish. Posts made from material conforming to ASTM A653 shall be formed from steel which has been zinc coated according to ASTM A653, Coating Designation Z275 (G90). Posts made from material conforming to ASTM A1011 shall be coated according to the applicable provisions of AASHTO M181 for Grade 2 posts, except the exterior zinc coating may be one-half of the required weight.

(e) Size. Sizes shall conform to those shown on the plans.

# SECTION 718

## TIMBER MATERIAL

### SCOPE

**718.01.01 Materials Covered.** This specification covers the quality requirements for structural timber, round timber piles, lumber, guardrail posts and blocks, markers, miscellaneous items, and timber preservatives.

This specification also covers the quality of bolts, nuts, washers, drift pins, dowels, nails, spikes, and other metal fastenings used in timber structures.

### REQUIREMENTS

**718.02.01 Certificates of Inspection.** Furnish inspection certificates with each shipment of timber. These certificates shall be issued by the inspection agency under whose rules the material was manufactured and graded.

Timber piles to be treated shall be inspected before treatment by an inspector designated by the Engineer. The inspector shall stamp each pile on the butt end with a stamp which shall make an impression that is readily legible after treatment. The stamp shall be copyrighted and a true impression filed with the Department.

### PHYSICAL PROPERTIES AND TESTS

**718.03.01 Species.** The standard commercial and botanical names recognized by these specifications are described as follows:

| Standard Commercial Name | Botanical Name |
|---|---|
| Douglas Fir (coastal) | Pseudotsuga menziesii var. menziesii |
| Douglas Fir (interior) | Pseudotsuga menziesii var. glauca |
| Western Hemlock | Tsuga heterophylla |
| Western Larch | Larix occidentalis |
| Lodgepole | Pinus contorta |
| Redwood | Sequoia sempervirens |
| Southern Pine | Pinus taeda |
| Ponderosa Pine | Pinus ponderosa |
| Jack Pine | Pinus banksiana |

**718.03.02 Grades.** Structural timber and lumber shall meet the requirements for the numerical stress shown on the plans, or as may be otherwise specified, when graded by rules developed according to AASHTO M168. Any commercial grading rules that will provide material of an equal or greater stress value may be used.

The West Coast Lumber Inspection Bureau and the Western Wood Products Association grading rules shall be included as grading rules which may be used. Grading rules in effect on the date of advertisement of bids shall govern.

Guardrail posts and blocks shall meet the following requirements:

1. Douglas Fir or Western Larch shall conform to the requirements for “No. 1 Structural” grade as set forth in the grading rules of the West Coast Lumber Inspection Bureau or the grading rules of the Western Wood Products Association.

2. Western Hemlock shall conform to the requirements for “Select Structural” grade as set forth in the grading rules of the West Coast Lumber Inspection Bureau or the grading rules of Western Wood Products Association.

3. Southern Pine shall conform to the requirements for “No. 1 SR” grade as set forth in the grading rules of the Southern Pine Inspection Bureau.

Timber piles shall conform to ASTM D25.

**718.03.03 Preservatives.** The following preservatives listed in these specifications shall conform to the requirements of the referenced American Wood-Preservers' Association (AWPA) Standards:

(a) Creosote shall conform to AWPA Standard P1.

(b) Creosote-Solution shall conform to AWPA Standard P2.

(c) Creosote-Petroleum shall conform to AWPA Standard P3.

(d) Pentachlorophenol shall conform to AWPA Standard P8.

(e) Ammoniacal Copper Arsenate (ACA), Ammoniacal Copper Zinc Arsenate (ACZA), and Chromated Copper Arsenate (CCA), Type A, B, or C, shall conform to AWPA Standard P5.

(f) Copper Naphthenate shall conform to the requirements of AWPA Standard P8.

Use a method of seasoning, conditioning, and treating conforming to AWPA Standards for each usage.

The minimum amount of preservative retained per cubic meter (cubic foot) of timber, lumber, or piling shall conform to the minimum specification requirements shown in Table I of this Subsection.

**TABLE I**
**PRESERVATIVE TREATMENTS**

| Usage and Wood Species | | Type of Preservative Treatment and Minimum Retention - kg/m$^3$ (lb/ft$^3$) of wood | | | | | | | AWPA Treatment Standard |
|---|---|---|---|---|---|---|---|---|---|
| | | A | B | C | D | E | F | G (c) | |
| Posts and Blocks for Guardrail: Coastal Douglas Fir, Western Larch, Western Hemlock, and Southern Pine | | 128.0 (8.0) | — | 8.0 (0.50) | 8.0 (0.50) | 8.0 (0.50) | 8.0 (0.50) | (d) 1.2 (0.075) | UC4B |
| Posts and Braces for Fences: Coastal or Interior Douglas Fir (a), Western Larch, Southern Pine, and Lodgepole Pine | Round | 128.0 (8.0) | 128.0 (8.0) | 6.4 (0.40) | 6.4 (0.40) | 6.4 (0.40) | 6.4 (0.40) | (e) 0.90 (0.056) | UC4B |
| | Sawn Four Sides | 160.0 (10.0) | 160.0 (10.0) | 8.0 (0.50) | 8.0 (0.50) | 8.0 (0.50) | 8.0 (0.50) | (d) 1.0 (0.062) | UC4B |
| Posts for Signs: Coastal or Interior Douglas Fir, Western Hemlock, and (b) | | 160.0 (10.0) | 160.0 (10.0) | 8.0 (0.50) | 8.0 (0.50) | 8.0 (0.50) | 8.0 (0.50) | (d) 1.0 (0.062) | UC4B |
| Round Timber Piles: Southern Pine | | 160.0 (10.0) | 160.0 (10.0) | 9.6 (0.60) | 12.8 (0.80) | 12.8 (0.80) | 12.8 (0.80) | — | UC4C |
| Round Timber Piles: Costal or Interior Douglas Fir, and Western Larch | | 160.0 (10.0) | 160.0 (10.0) | 13.6 (0.85) | 16.0 (1.0) | 16.0 (1.0) | — | — | UC4C |

**A = Creosote or Creosote-Petroleum**
**B = Creosote-Solution**
**C = Pentachlorophenol**
**D = ACA**
**E = ACZA**
**F = CCA**
**G = Copper Naphthenate**

(a) Interior Douglas Fir is not allowed for round posts.
(b) Any other equivalent stress rated wood.
(c) As kg/m$^3$ (lb/ft$^3$) copper.
(d) Coastal Douglas Fir and Southern Pine only.
(e) Copper Naphthenate in AWPA P9 Hydrocarbon Solvent Type A and only for Douglas Fir, Southern Pine, or Lodgepole Pine.

The treating plant shall imprint legible symbols in the treated material indicating the name of the treating company and the type and year of treatment according to AWPA Standards.

Furnish inspection certifications from the supplier stating that the treated material complies with all the requirements of these specifications. Each certification shall include a listing of the material being supplied and have attached a certified test report as detailed in AWPA Standards from the plant inspector.

All materials and processes used in the manufacture of treated material may be subjected to inspection, acceptance, or rejection at the manufacturer's plant. Equip the plant with all the necessary gages, appliances and facilities to enable the inspector to satisfy himself that the requirements of the specifications have been fulfilled.

Care and handle pressure treated wood according to AWPA Standards.

**718.03.04 Hardware.** Galvanize iron and steel hardware, according to ASTM A153.

Bolts, nuts, dowels, and drift pins shall conform to ASTM A307, Grade A.

Fabricate cast washers of cast iron of the O-gee type. The diameter shall be not less than 3.5 times the diameter of the bolts. The diameter of the hole shall be 3 mm (1/8 in.) larger than the diameter of the bolt.

Fabricate flat malleable washers of malleable iron with ribs properly proportioned to develop the full strength of the bolt. The diameter shall be not less than 3.5 times the diameter of the bolt for which it is used, and the thickness shall be equal to one-half the diameter of the bolt. The diameter of the hole shall be 3 mm (1/8 in.) larger than the diameter of the bolt.

Use a standard commercial type of cut or round nail. Use cut, round or boat spikes, as specified.

# SECTION 719

## RIPRAP

### SCOPE

**719.01.01 Materials Covered.** This specification covers the types and quality of riprap and riprap bedding.

### REQUIREMENTS

**719.02.01 General.** Material for riprap and riprap bedding shall be hard, durable, angular in shape; resistant to weathering and water action; free from overburden, spoil, shale, and organic material; and shall meet the gradation requirements specified.

Control of gradation will be by visual inspection. If directed, provide 2 samples of material of a least 5 metric ton (5.5 ton) each, meeting the gradation specified. Provide one sample at the construction site, which may become part of the finished work. Provide the other sample at the quarry. These samples will be used as a frequent reference for judging the gradation of the material supplied. Resolve any difference of opinion between yourself and the Engineer by dumping and checking the gradation of 2 random truck loads of material. Provide mechanical equipment, a sorting site, and labor needed to assist in checking the gradation.

### PHYSICAL PROPERTIES AND TESTS

**719.03.01 Stone for Riprap.** This stone shall conform to the following requirements:

**RIPRAP GRADATIONS**
**mm (in.)**

| | CLASS DESIGNATIONS | | | | | |
|---|---|---|---|---|---|---|
| **Percent Passing by Mass** | **150** | **300** | **400** | **550** | **700** | **900** |
| 100 | 250 (10) | 500 (20) | 750 (30) | 1000 (40) | 1200 (48) | 1500 (60) |
| 70-85 | 225 (9) | 450 (18) | 675 (27) | 900 (36) | 1125 (45) | 1350 (54) |
| 35-50 | 150 (6) | 300 (12) | 450 (18) | 600 (24) | 750 (30) | 900 (36) |
| 5-15 | 50 (2) | 125 (5) | 175 (7) | 300 (12) | 450 (18) | 600 (24) |
| 0-5 | 25 (1) | 50 (2) | 75 (3) | 150 (6) | 200 (8) | 300 (12) |

| Source Requirement Tests | Test Method | Requirements |
|---|---|---|
| Percentage of Wear, 500 Rev. | AASHTO T96 | 45% Max. |
| Specific Gravity | Nev. T104 | 2.5 Min. |

The largest dimension of a single riprap stone shall be no larger than 3 times the smallest dimension. Rounded stone or boulders will not be accepted. Shale and stone with shale seams are not acceptable.

**719.03.02 Aggregate for Riprap Bedding.** This aggregate shall conform to the following requirements:

**CLASS 150 RIPRAP BEDDING**

| Sieve Size | Percent Passing by Mass |
|---|---|
| 25 mm (1 in.) | 100 |
| 16 mm (5/8 in.) | 70-85 |
| 9.5 mm (3/8 in.) | 35-50 |
| 6.3 mm (1/4 in.) | 5-15 |
| 4.75 mm (No. 4) | 0-5 |

**CLASS 300/400 RIPRAP BEDDING**

| Sieve Size | Percent Passing by Mass |
|---|---|
| 150 mm (6 in.) | 100 |
| 125 mm (5 in.) | 70-85 |
| 75 mm (3 in.) | 35-50 |
| 25 mm (1 in.) | 5-15 |
| 12.5 mm (1/2 in.) | 0-5 |

**CLASS 550/700 RIPRAP BEDDING**

| Sieve Size | Percent Passing by Mass |
|---|---|
| 250 mm (10 in.) | 100 |
| 225 mm (9 in.) | 70-85 |
| 150 mm (6 in.) | 35-50 |
| 50 mm (2 in.) | 5-15 |
| 25 mm (1 in.) | 0-5 |

**CLASS 900 RIPRAP BEDDING**

| Sieve Size | Percent Passing by Mass |
|---|---|
| 500 mm (20 in.) | 100 |
| 450 mm (18 in.) | 70-85 |
| 300 mm (12 in.) | 35-50 |
| 125 mm (5 in.) | 5-15 |
| 50 mm (2 in.) | 0-5 |

| Source Requirement Tests | Test Method | Requirements |
|---|---|---|
| Percentage of Wear, 500 Rev. | AASHTO T96 | 45% Max. |
| Specific Gravity | Nev. T104 | 2.5 Min. |

# SECTION 720

## GUARDRAIL MATERIALS

SCOPE

**720.01.01 Materials Covered.** This specification covers the quality and kind of material used in the construction of guardrail.

REQUIREMENTS

**720.02.01 Certificates.** Furnish 2 certified copies of mill test reports showing the chemical and physical characteristics from each heat from which metal is used.

Rail members, bolts, nuts, and other fittings shall be interchangeable with similar parts regardless of source.

PHYSICAL PROPERTIES AND TESTS

**720.03.01 Rail Members.** The beam-type members, comprised of rail members and end or terminal pieces, shall conform to AASHTO M180, Type I, Class A, except galvanize after fabrication.

**720.03.02 Fittings.** All bolts, nuts, washers, and other fittings for beam-type guardrail shall be galvanized steel meeting AASHTO M180.

All bolts, nuts, and washers shall be 16 mm (5/8 in.) size. Bolts shall be button-head style and nuts shall be hexagonal. Bolts and nuts shall be coarse-threaded [11 threads per 25 mm (1 in.)], with nuts tapped oversize not to exceed 0.8 mm (1/32 in.). Outside dimensions of boltheads, nuts, and washers shall have the following minimums: boltheads, 32 mm (1 1/4 in.); nuts, 24 mm (15/16 in.); and washers, 38 mm (1 1/2 in.). Splice bolts shall be 32 mm (1 1/4 in.) in length, and post connection bolts shall be of lengths required to fit the post dimension and extend beyond the tightened nuts thereon within limits of 6 to 13 mm (1/4 to 1/2 in.). Provide washers, 3 mm (1/8 in.) thick, for use under nuts on all post bolts, and under any nut which has a width of less than 27 mm (1 1/16 in.).

Bolts for guardrail to barrier rail and guardrail to bridge rail connections shall be of lengths required to fit the dimension and extend beyond the tightened nuts thereon within limits of 6 to 13 mm (1/4 to 1/2 in.).

Galvanize fittings according to Section 715.

**720.03.03 Guardrail Anchor Hardware.** Provide cable and fitting for guardrail anchors that conforms to AASHTO M30, Class C, for Type II cable. Galvanize all fittings according to AASHTO M111.

**720.03.04 Metal Guardrail Posts.** Metal posts shall be of structural steel conforming to ASTM A36 and galvanized according to AASHTO M111.

**720.03.05 Wood Guardrail Post.** Wood posts and blocks shall be rough or surfaced to the dimensions shown in the plans and shall conform to Section 718.

# SECTION 721

## OBJECT MARKERS AND GUIDE POSTS

### SCOPE

**721.01.01 Materials Covered.** This specification covers the quality and kind of materials used in the construction of object markers and guide posts.

### REQUIREMENTS

**721.02.01 Certificates.** Furnish 2 certificates covering each order of material (plates, reflectors, and posts) by the manufacturer, certifying that the product complies with the specifications. Deliver certificates at the time of, or before, delivery of the order.

### PHYSICAL PROPERTIES AND TESTS

**721.03.01 Metal Posts.** Posts shall be steel conforming to ASTM A1011, Grade 275 (Grade 40), or ASTM A653, Designation SS, Grade 275 (Grade 40), and be of 3.2 to 3.5 mm (10 or 11 gage) thickness.

Galvanize metal posts according to Section 715, or according to ASTM A653, coating designation Z700 (G235).

**721.03.02 Target Plates.** (a) Base Metal. Base metal for target plates shall be zinc-coated steel sheet or aluminum sheet.

The zinc-coated steel sheet shall comply with FSS QQ-S-775 Steel Sheet, carbon, zinc-coated Type 1, Classes d and e, except that the zinc-coated surface shall withstand a 180 degree bend on itself at room temperature without flaking the coating. Prepare the zinc-coated surface for painting by the application of phosphate coating. Accomplish the phosphatizing process without damaging or removing the galvanized coating from the steel base metal. Any evidence of damage or removal of the zinc coating shall be cause for rejection of the entire lot.

Prepare the aluminum sheet for painting with a chemical conversion coating conforming to MIL-C-5541. Apply the coating according to the manufacturer's specifications and recommended sequence of operation. Furnish 2 copies of certified mill tests of the aluminum sheets.

Fabricate target plates from 1.0 mm thick (20 gage) steel sheet or 1.3 mm (0.05 in.) thick aluminum sheet, alloy 3005-H14 conforming to ASTM B209.

Accomplish fabrication of all metal parts in a uniform and workmanlike manner. Cut plates to size and shape and punch the holes for mounting bolts and reflectors according to the details shown on the plans. Provide surfaces and edges of the plates free from defects resulting from fabrication.

(b) Paint. Target plates shall have satisfactory paint adherence.

Furnish metal reflector plates for metal guide posts with one or both sides coated with a black, baked enamel finish. If only one side is coated, the coated side shall face oncoming traffic.

Coat the plates with baked enamel conforming to the following provisions:

> The enamel finish coat for plates shall comply to Federal Specification TT-E-489, Class B baking type enamel.
>
> Apply the enamel by spraying, rolling, or dipping. Other methods may be used provided they are approved before use. The dry film thickness of the baked enamel coating on the galvanized steel plates shall be not less than 50 µm (2 mils). The dry film thickness on the aluminum plates shall be not less than 38 µm (1.5 mils) if enamel is applied by spray or dip method and not less than 25 µm (1 mil) if enamel is applied by continuous roller coat method. Provide uniform coating which is smooth and free from flow lines, streaks, blisters, or other surface imperfections.

Provide finished plates without dents and defects. The maximum surface deviation from a horizontal plane on which the finished plate lies shall not exceed 6 mm (1/4 in.).

(c) Hardware. Hardware for attaching the target plates shall consist of 6 mm (1/4 in.) diameter galvanized steel or aluminum nuts and bolts or 5 mm (3/16 in.) diameter rivets and washers. Commercial quality hardware will be acceptable.

**721.03.03 Reflectors.** Equip guide posts and object markers with Type IV, Type IX, or Type XI reflective sheeting conforming to Subsection 716.03.01.

The size of the sheeting shall be as indicated on the plans. The color of the sheeting shall be as indicated in the MUTCD.

# SECTION 722

## WATER

SCOPE

**722.01.01 Material Covered.** This specification covers the quality of water.

REQUIREMENTS

**722.02.01 General.** Water for embankments, backfill, subgrade, base, landscaping, and surface courses and cement concrete curing shall be free from an excessive amount of acids, alkali, oil, and other substances which will cause damage to the above mentioned items.

PHYSICAL PROPERTIES AND TESTS

**722.03.01 Concrete Use.** Submit two, 1 liter (1 quart), samples of water for tests, obtained and shipped in clean containers carefully packed and labeled. Tests will be made according to AASHTO T26.

Water with a pH less than 4.5 or greater than 8.5 and a resistivity less than 500 ohm•cm will be tested according to AASHTO T26. Any indication of unsoundness, marked change in time of setting, or a reduction of more than 10% in strength from results obtained with concrete mixtures containing the water of satisfactory quality shall be sufficient cause for rejection of the water under tests.

**722.03.02 Cold Recycle Use.** Submit a 1 liter (1 quart) sample of the water to be used a minimum of 15 working days before the start of cold recycle operations. The water shall not contain more than 500 ppm total sulfates.

# SECTION 724

## FENCE MATERIALS

SCOPE

**724.01.01 Materials Covered.** This specification covers the quality of barbed wire, woven wire, and chain-link fabric fencing, fence posts, gates, and miscellaneous fence hardware.

REQUIREMENTS

**724.02.01 Samples and Certificates of Inspection.** Furnish 2 certificates covering each order of material by the manufacturer, certifying that the various metal components comply with the requirements herein. Deliver the certificates at the time of, or before, delivery of the order.

PHYSICAL PROPERTIES AND TESTS

**724.03.01 Wood Posts.** Intermediate braced posts and braces shall be of the same type as line posts.

End, gate, and corner post assemblies, including bracing timber, shall be sawed lumber and shall conform to the grading requirements of Section 718. They shall be of Douglas Fir, Western Larch, or Southern Pine.

Line posts and intermediate braced posts and bracing shall be round and shall be of Douglas Fir, Southern Pine, Lodgepole Pine, or Western Larch manufactured from sound live trees well seasoned and free from large knots, shakes, or splits or other defects which will impair their strength or durability. Peel the posts and braces to remove all outer bark and all inner cambium bark, except an occasional strip of inner bark may remain if not over 13 mm (1/2 in.) wide or 75 mm (3 in.) long. Trim knots flush with the side, remove spurs and splinters, and cut ends square.

The small end of round line posts and braces shall be between 90 and 115 mm (3.5 and 4.5 in.) in cross sectional dimension; the small end of intermediate braced posts shall be between 140 and 165 mm (5.5 and 6.5 in.) in cross sectional dimension. The allowable taper from end to end of round posts and braces shall not exceed 38 mm (1.5 in.).

Pressure treat posts and braces according to Section 718. Treat all posts and braces with the same type of preservative.

When pressure treated materials have been damaged or when it has been absolutely necessary to cut or bore into them, after delivery to the job site, carefully field treat all exposed untreated wood with preservative applied either by thorough swabbing or by an approved bolt-hole treater.

Corner, end, pull, line, brace, and gate posts shall be of the type, size weight, and length shown on the plans.

**724.03.02 Metal Posts.** Steel pipe posts shall be Class 1 or Class 2 and conform to the following:

1. Class 1 pipe posts shall be galvanized standard weight steel pipe (Schedule 40) conforming to ASTM F1083.

2. Class 2 pipe posts shall be Grade 1 or 2 conforming to AASHTO M181, except that Grade 2 shall be only zinc plus organic coated.

Fabricate C-section and Type II posts and braces from roll formed steel conforming to ASTM A1011, Grade 45 and zinc coat or zinc plus organic coat according to AASHTO M181.

Pre-galvanized C-sections and Type II posts may be used provided the edges are coated in conformance with ASTM A780.

Manufacture T-section posts of steel conforming to ASTM A283, A663, or A675, or manufacture to comply with AASHTO M281, T-section type. Manufacture T-section posts to tolerances and workmanship as provided in AASHTO M281.

Provide T-section posts with tapered anchor plates attached securely thereto. The anchor plates shall weigh not less than 0.30 kg (0.67 lb) and have a minimum area of 11,600 $mm^2$ (18 $in.^2$). The anchor plate may be omitted provided the post is set in concrete. Furnish each post with galvanized wire clamps as follows: one clamp for each strand of barbed wire or smooth wire; and clamps for the top, bottom and at not more than 350 mm (14 in.) intervals between top and bottom for mesh fencing.

Galvanize T-section posts or paint with anticorrosive paint. Drill, notch, or stud the post to facilitate fastening the fencing.

**724.03.03 Barbed Wire.** Barbed wire shall conform to ASTM A121, Coating Type Z, Coating Class 1, Design Number 12-4-5-14R. Smooth wire shall meet the requirements for barbed wire, except the wire shall not have barbs.

**724.03.04 Woven Wire.** Woven Wire shall conform to ASTM A116, 2.51 mm (No. 12 1/2) Farm, except that the minimum weight of coating shall be 61 $g/m^2$ (0.2 $oz/ft^2$) of uncoated wire surface.

**724.03.05 Chain Link Fabric.** Chain-link fabric and required fittings, hardware, and pedestrian rail shall conform to AASHTO M181, Type I or Type II, except that for Type I galvanize the fabric with the minimum weight of coating of 366 $g/m^2$ (1.2 $oz/ft^2$) of uncoated wire surface. Use 3.05 mm (11 gage) wire in the manufacture of the fabric for chain link fence 1,800 mm (72 in.) or less in height, and provide mesh size of 50 mm (2 in.). Use 3.76 mm (9 gage) wire in the manufacture of the fabric, for pedestrian rail and with a mesh size of 25 mm (1 in.).

The tension wire shall conform to AASHTO M181.

**724.03.06 Staples, Brace Wire, and Nails.** Use 4.27 mm (8 gage) brace wire, medium temper, 379 to 517 MPa (55 to 75 ksi) tensile strength and galvanize according to the requirements specified for barbed wire.

Make staples from 3.76 mm (No. 9) galvanized wire of the U-shaped type, 44 mm (1 3/4 in.) long.

**724.03.07 Metal Gates.** (a) Drive Gates for Standard Fencing. Construct the gate frames of not less than NPS 1 galvanized standard weight pipe conforming to the dimensions, nominal weights, and galvanizing specified in ASTM A53 (hydrostatic test will not be required). Place galvanized tubular steel braces vertically in each gate, and secure corner and brace joints so that the gate will retain a true rectangular shape.

Use rectangular mesh or 50 mm (2 in.) diamond mesh and galvanize according to the requirements herein specified for woven wire fabric.

(b) Drive Gate for Chain-Link Fencing. Construct the gate frame of not less than NPS 1 1/2 galvanized standard weight pipe conforming to the dimensions, nominal weights, and galvanizing specified under ASTM A53 (hydrostatic test will not be required). Cross-trim the gate frames with galvanized 9.5 mm (3/8 in.) adjustable truss rods. Fasten the corners of the gate frames together and reinforce with malleable iron fittings designed for the purpose of welding.

Attach chain-link fence fabric as specified for the fence to the gate frame by the use of stretcher bars and tie wires as specified for fence construction. Space suitable tension connectors at approximately 300 mm (1 ft) intervals.

(c) Walk Gates. Construct walk gates 1,050 mm (42 in.) wide and of the height corresponding to the adjacent fence. Furnish the gate complete with approved hinges, latches, and auxiliary braces as required.

Construct the gate frame of not less than NPS 3/4 galvanized standard weight pipe conforming to the dimension, nominal weights, and galvanizing specified under ASTM A53 (hydrostatic test will not be required). Fill the gate frame with chain link fabric meeting the requirements specified herein.

**724.03.08 Tortoise Fence.** (a) Steel Hardware Cloth. The steel hardware cloth attached along the bottom of chain link fence shall be a commercial quality welded galvanized steel wire fabric with 25 mm x 50 mm (1 in. x 2 in.) mesh size and 1.5 mm (16 gage) minimum diameter wire.

# SECTION 725

## ELASTOMERIC BEARING PADS

### SCOPE

**725.01.01 Material Covered.** This specification covers the materials, manufacture, and testing of plain elastomeric bearings and steel laminated elastomeric bearings.

### REQUIREMENTS

**725.02.01 Certificate of Inspection.** Elastomeric bearing pad materials and completed bearings shall be tested by the manufacturer or an approved independent testing laboratory, who shall certify that the constituent materials and completed bearings meet these specifications and requirements. The certification shall include a certified copy of the test results on samples of the elastomer and laminated materials to be used in the pads. Furnish material and bearing testing certifications prior to installing the bearings.

### PHYSICAL PROPERTIES AND TESTS

**725.03.01 General.** Elastomeric bearing pads shall conform to AASHTO M251 except modified as follows or as otherwise indicated on the plans:

1. Elastomer shall be 100% virgin crystallization resistant polychloroprene (neoprene).

2. Elastomer shall be Grade 3 with a durometer hardness of 55 ± 5.

3. Steel laminates shall conform to ASTM A1011M Grade 250 (A1011 Grade 36).

4. The alternate test and acceptance criteria referenced in Section 3.5 of AASHTO M251 are not permitted.

5. The maximum design dead load plus live service compressive load is 6900 kPa (1000 psi) unless shown otherwise on the plans.

6. The compressive strain at the maximum design dead load plus live service compressive load shall not exceed 0.10.

7. The optional AASHTO M251 test procedures shall apply if the plans indicate the bearing was designed based on AASHTO Method B.

# SECTION 726

## ROADSIDE MATERIALS

SCOPE

**726.01.01 Materials Covered.** This specification covers the materials used in erosion control, landscaping, and irrigation systems.

REQUIREMENTS

**726.02.01 Certificates and Samples.** (a) Topsoil. Obtain from the County Weed Control Agency or the State Quarantine Officer a written certification that the area from which the topsoil is to be obtained is free from noxious weeds. Topsoil that has been treated with herbicides or sterilants shall be tested by the State Department of Agriculture to determine the residuals in the soil.

Before imported topsoil is brought on the jobsite, furnish a current report from a recognized testing laboratory indicating the particle size, clay content, the pH factor, and electrical conductivity of the sample.

(b) Fertilizer. Provide fertilizer containers with the manufacturer's guaranteed statement of analysis clearly marked, all conforming to State and Federal laws. The State Department of Agriculture shall sample the fertilizer before use on the project.

(c) Compost. Before bulk compost is brought to the jobsite, samples shall have been tested for the specified microbiological and nutrient conditions, including maturity and stability, by a testing laboratory approved for testing of organic materials. Such testing shall have been performed within six months of time the humus is to be furnished to the project. Submit test results for approval.

(d) Plants. Plants shall comply with Federal and State laws requiring inspection for plant diseases and infestations. Furnish inspection certificates required by law with each shipment of plants. Furnish certificates for USDA Quarantine No. 63 for White Pine blister rust, and Nevada Quarantine No. 54.05 for European Pine shoot moth with shipments of pines.

(e) Seeds. Furnish duplicate copies of a statement signed by the vendor certifying that each lot of seed has been tested by a recognized seed testing laboratory within 6 months before the date of seeding on the project. Submit original laboratory seed tests by lot number a minimum of 30 days before application. Seed tags shall reflect the most recent test date and shall be submitted for approval. All seed is subject to inspection. The State Division of Agriculture shall randomly sample and test seed before use on the project. Furnish a copy of the State Division of Agriculture's approval letter.

(f) Irrigation Materials. Ascertain that all required tests have been made by approved qualified testing laboratories. Furnish a written certification that all required tests have been satisfactorily completed and that materials and fabrication thereof comply with all the requirements. Receive approval of material before use.

(g) Soil Inoculants. Provide 28 gram samples with package labels 30 days prior to application for verification of species and live propogules. Obtain a composite sample from the top, middle, and bottom of the bag and/or micro-bag samples per case. Submit samples to a soils laboratory capable of testing these samples using the mean Infection Percentage (MIP) assay test method. Submit lab test results for approval.

(h) Herbicides. Provide herbicide certificates with the manufacturer's guaranteed statement of analysis clearly marked, all conforming to State and Federal laws, including pre-emergent herbicides. Herbicides shall not contain soil sterilants.

(i) Mulch. Provide mulch certification with the manufacturer's guaranteed statement of analysis clearly marked, all conforming to State and Federal laws.

(j) Tackifier. Provide tackifier certification with the manufacturer's guaranteed statement of analysis clearly marked, all conforming to State and Federal laws. The standard swell volume shall be considered as 30 milliliters per gram. Material shall have a swell volume of at least 24 milliliters per gram.

(k) Woven Fabric (Weed Barrier). Provide manufacturer's certification that all materials and fabrication thereof comply with all the requirements. Receive approval of material before use.

PHYSICAL PROPERTIES AND TESTS

**726.03.01 Topsoil.** Topsoil shall consist of fertile, friable soil of loamy character, and shall contain an amount of organic matter normal to the region. Obtain topsoil from well-drained arable land and reasonably free from subsoil, refuse, roots, heavy or stiff clay, stones larger than 25 mm (1 in.) in largest dimension, coarse sand, sticks, brush, litter, and other deleterious substances. Topsoil shall be capable of sustaining healthy plant life.

Requirements for topsoil shall be as follows:

| | |
|---|---|
| Particle Size | 9.5 mm (3/8 in.) Maximum |
| Clay Content | 20% Maximum, by mass |
| pH Factor | 6.4 to 7.4 |
| Electrical Conductivity | 0.5 to 1.0 mmho/cm of the saturation paste extract |

**726.03.02 Topsoil (Salvage).** The material consists of a mix of native soil, broken-up surface vegetation and rock materials harvested from the project footprint as shown on the plans. The project footprint is the areas which shall be excavated or covered by fill.

Topsoil consists of the top 150 mm (6 in.) of material, including surface vegetation and rock, as referenced vertically from the existing ground. Do not substitute material derived from deeper segments, or material from outside of the project limits without approval.

Use topsoil that is free from construction wastes, petroleum byproducts, trash, or other manmade materials. Break the vegetation into pieces 150 mm (6 in.) or less in the longest dimension.

Mechanically process removed topsoil, vegetation, and rock to separate material that does not pass through a screen with 150 mm (6 in.) square openings. Consider material in excess of 150 mm (6 in.) waste and do not reintroduce this material to topsoil. Rock exceeding 150 mm (6 in.) may be salvaged and used as specified.

**726.03.03 Water.** Water shall be free of oil, acid, salts, or other substances which are harmful to plants. The source shall be as approved prior to use.

**726.03.04 Herbicides.** Use herbicides and pre-emergent herbicides listed in the QPL.

**726.03.05 Fertilizer.** Fertilizer shall be of a standard commercial grade of organic or inorganic fertilizer of the kind and quality specified in the contract documents, and based on a soils analysis test conducted on soils placed in final graded condition and for plants specified on the plans. Fertilizer may be separate or in a mixture containing the percentage of total nitrogen, available phosphoric acid, and water-soluble potash in the amounts specified. Furnish fertilizers in standard unopened containers with mass, name of plant nutrients, and manufacturer's guaranteed statement of analysis clearly marked, all according to State and Federal laws.

Acceptable commercial fertilizer will be specified in one of the following forms:

(a) A dry free-flowing granular fertilizer, suitable for application by agricultural fertilizer spreader.

(b) A soluble fertilizer ground to a fineness that will permit complete suspension of insoluble particles in water, suitable for application by power sprayer.

(c) A granular or pelleted fertilizer, suitable for application by blower equipment.

(d) A nonvolatile liquid fertilizer.

Commercial fertilizer (tablets) shall be tightly compressed tablets weighing approximately 21 g designed for the establishment of trees and shrubs. Fertilizer tablets shall conform to the following chemical analysis:

| | **Minimum Percentage** |
|---|---|
| Organic Nitrogen (derived from Urea-Form) | 20.00 |
| Available Phosphoric Acid (derived from calcium phosphate) | 10.00 |
| Soluble Potash (derived from potassium sulfate) | 5.00 |
| Combined Sulfur (derived from ferrous ammonium and potassium sulfate) | 1.60 |
| Iron (expressed as metallic, derived from ferrous ammonium sulfate | 0.35 |

With written permission, commercial fertilizer tablets designed for the same purpose with a quantitative analysis that deviates from that listed above may be used.

**726.03.06 Compost.** Compost shall be processed, composted, fine ground organic vegetative materials. Supply compost free of lumps or clods. The compost shall pass a 12.5 mm (1/2 in.) sieve, and 85% shall pass a 3.35 mm (No. 6) sieve. The compost shall not have ammonia or anaerobic odors.

Compost shall also conform to the following requirements:

| | |
|---|---|
| Cation Exchange Capacity (CEC) | Greater than 50 meq/100 g |
| Carbon:Nitrogen Ratio | Less than 20:1 |
| pH (of extract) | 6.0 – 8.5 |
| Organic Matter Content | Greater than 25% |
| Total Nitrogen (not added) | Greater than 1% |
| Humic Acid | Greater than 5% |
| Maturity Index | Greater than 50% on Maturity Index at a 10:1 ratio |
| Stability | Less than 100 mg - $O^2$/Kg compost dry solids – hour |

**726.03.07 Mulch.** Use mulch listed in the QPL.

(a) Straw Mulch. Provide straw mulch materials in an air-dried condition free of noxious weeds, weed seeds, and other materials detrimental to plant life. Provide straw mulch material of approved field grasses indigenous to the area. Obtain from the State Division of Agriculture a written certification that the straw is free of noxious weeds.

Rye straw and oat straw will not be acceptable.

Hydraulically applied straw mulch shall be wheat or rice straw processed to various particle sizes, mixed with water and tacking material, and applied as a non-clogging slurry using a hydro-seeder. A minimum of 70% of the wheat or rice straw in the mix shall be not less than 12.5 mm ± 6 mm (1/2 in. ± 1/4 in.) in length. Straw particles may be longer provided that the particles can be used with the selected hydro-seeder without clogging. Hydraulically applied straw mulch, as furnished by the manufacturer, may contain up to 10% paper or cotton materials in dry weight, as well as 5% to 20% of wood fiber in dry weight. The combined dry weight percentage of paper, cotton, and wood fiber materials together shall be 15% to 30% of the mulch.

(b) Thermally-Refined Wood Fiber. Wood cellulose fiber mulch shall be from thermo-mechanically processed wood, processed to contain no growth germination inhibiting factors and dye a suitable color to facilitate inspection of the placement of the material. The mulch shall be from virgin wood manufactured and processed so the fibers will remain in uniform suspension in water under agitation to form homogenous slurry. Paper products will not be considered as virgin wood.

The material shall conform to the following requirements:

| | |
|---|---|
| Virgin Wood Cellulose Fiber | 90% Minimum |
| Recycled Cellulose Fiber | 10% Maximum |
| Ash Content | 0.8% ± 0.3% |
| pH | 3.5 to 5.5 |
| Water Holding Capacity (water:fiber) | 10:1 Minimum |

(c) Wood Chips and Shavings. Manufacture shavings from any clean softwood. Manufacture wood chips from any clean, green softwood. Do not supply chips from kiln-dried or air-dried material. Produce chips by machinery equipped with knives or blades which cut rather than shred or break the material. Grade chips so that substantially all chips are from 12.5 to 75 mm (1/2 to 3 in.) in length, 12.5 to 38 mm (1/2 to 1 1/2 in.) in width and from 3 to 12.5 mm (1/8 to 1/2 in.) in thickness.

**726.03.08 Tackifier.** Use tackifiers listed in the QPL. Tacking agent shall be a naturally occurring organic compound, and shall be non-toxic. The tacking agent shall be a product typically used for binding soil and mulch in seeding or erosion control operations. Approved types shall consist of mucilage or gum by dry weight as active ingredient obtained from guar or plantago. The tacking agent shall be labeled indicating the type and mucilage purity.

**726.03.09 Erosion Control Fabric.** Erosion control fabric shall be as specified in the contract documents.

**726.03.10 Plants.** Supply nursery grown plants representative of their normal species and true to type or name as shown on the plans and conforming to the American Standard for Nursery Stock, No. 1 grade, AAN, Inc., latest edition, ASA Spec. Z 60.1. Tag plants by the most recent standard practice recommended by the AAN and to the latest edition of Standardized Plant Names, as adopted by the American Joint Committee on Horticultural Nomenclature.

**726.03.11 Seeds.** Furnish grasses, legumes, or cover crop seed in standard containers or sealed bags on which show the following information:

(a) Seed name, scientific and common name.

(b) Lot number.

(c) Net mass.

(d) Percentage of pure live seed including hard and dormant seed (in case of legumes, percentage of germination to include hard seed).

(e) Percentage of weed seed content and inert material clearly marked for each kind of seed according to applicable State and Federal laws. Weed seed shall not exceed 0.5% of the pure live seed and shall not include any seed of Cheatgrass (Bromus tectorum) or Sweet Clovers (Melilotus officianalis, M. alba). Crop seed shall not exceed 0.5% of the pure live seed.

(f) No noxious weed seed present.

(g) Percent crop seed.

(h) Supplier name, address, and phone number.

Do not use seed which has become wet, moldy, or otherwise damaged in transit or storage. Provide seed at least 95% pure and having a minimum of 85% germination. Store seed in a cool watertight facility with temperatures less than 27 °C (81 °F).

Within 60 days of contract award, submit a statement from the seed supplier that the order for the seed mixes was received by the supplier. Indicate in the statement if any of the seed species are projected to be in short supply. Species and or variety substitution will be allowed only upon written approval.

**726.03.12 Soil Inoculants.** Mycorrhizal inoculants shall consist of spores, mycelium, and mycorrhizal root fragments in a solid carrier suitable for handling by dry application. The carrier shall be the material in which the inoculum was originally produced and may include organic materials, vermiculite, perlite, calcined clay, or other approved materials consistent with proper application and good plant growth.

Each endomycorrhizal inoculum shall carry a supplier's guarantee of number of propagules per unit weight or volume of bulk material. The inocula shall contain at a minimum 120 live spores per gram. Label product bags with a lot number and the harvest date of the inocula. Provide 28 gram samples 30 days before application for verification of species and spore counts. Transport and store inocula in areas with a temperature less than 32 °C (90 °F) and keep temperatures above freezing.

**726.03.13 Tree Ties.** Tree ties shall be strips of vinyl coated nylon, rubber, or other flexible, durable, nonhardening, ultraviolet resistant, long-life material, approximately 25 to 50 mm (1 to 2 in.) wide and approximately 0.25 mm (10 mil) thick.

Tree tie shall be secured to a wooden post with one galvanized nail or 38 mm (1.5 in.) galvanized fence staple.

For 15 gallon and smaller trees use 0.6 m (24 in.) length tie and use 0.8 m (32 in.) length for all larger sized trees.

**726.03.14 Irrigation Pipe and Fittings.** (a) Copper pipe shall be Type K and sized to operate at velocity of less than 7 feet per second (fps).

(b) Plastic pipe, except drip lines, shall be polyvinyl chloride (PVC) 1120 or 1220 pressure pipe as shown on the plans and shall conform to ASTM D1785. Extrude PVC pipe from 100% virgin material approved by the National Sanitation Foundation (NSF). Plastic pipe, except drip lines, shall be pressure rated at 2070 kPa (300 psi) (Schedule 40) minimum. Bell and spigot PVC pipe may be used in lieu of plain end pipe and couplings. Fittings for PVC plastic pipe shall conform to ASTM D2466.

(c) Polyethylene used in the manufacture of polyethylene fittings shall conform to ASTM D1248, for Type III. Polyethylene fittings used in assembling swing joint risers shall be Schedule 80 conforming to ASTM D3261.

(d) Plastic pipe for drip lines shall be flexible PVC conforming to ASTM D2287, Cell-type 6640400. Wall thickness of drip lines shall conform to the following when determined according to ASTM D2122:

| Hose Size-Nominal mm (in.) | Minimum * mm (in.) | Range (%) |
|---|---|---|
| 15 (1/2) | 2.25 (0.090) | 12 |
| 20 (3/4) | 3.75 (0.150) | 12 |
| 25 (1) | 3.95 (0.158) | 12 |

* As measured at any point on the cross section

Plastic pipe for drip lines shall also contain a proven effective, algae resistant ingredient. Furnish certification to the effectiveness of the algae resistant ingredient upon request. Acceptable certification shall be the results of either:

1. Field test for at least 2 years under actual operating conditions or

2. Laboratory testing which closely approximates the full range of climatic conditions that would exist during any full calendar year, including exposure to algae under warm climatic conditions for a duration of 30 days.

Provide PVC plastic pipe which is homogeneous throughout, smooth inside and outside, free from cracks, holes, foreign materials, dents, wrinkles, and blisters.

**726.03.15 Sleeves and Conduit for Irrigation Systems.** Sleeves shall be PVC pipe conforming to ASTM D1785, SDR35. Water line sleeves shall be white Schedule 40 PVC pipe. Wiring conduit shall be gray Schedule 40 PVC pipe.

**726.03.16 Masonry.** Hollow load-bearing concrete masonry blocks shall conform to ASTM C90. Hollow non-load-bearing concrete masonry blocks shall conform to ASTM C129.

**726.03.17 Soil Stabilizer.** Soil stabilizer shall be as specified in the contract documents. Use soil stabilizers listed in the QPL.

# SECTION 728

## EPOXY

SCOPE

**728.01.01 Materials Covered.** This specification covers the type and quality of epoxy materials.

REQUIREMENTS

**728.02.01 Sampling and Testing.** Do not use epoxy before sampling and testing unless its use is permitted according to Subsection 106.05.

All tests will be conducted according to the test methods of the ASTM, Federal Test Method Standard No. 141, and methods in use by the Department.

**728.02.02 Certificates.** Furnish 2 certificates from the manufacturer covering each order of material, certifying that the product complies with the specifications. Deliver certificates at the time of, or before, delivery of the order.

**728.02.03 Packaging, Labeling, and Storing.** Package each component in steel containers not larger than 20 L (5 gal) in volume. When the components are to be mixed at a ratio of 2 parts A to 1 part B, by volume, the container containing component B shall be one-half the volume of the container containing component A. Provide new containers with lug type crimp lids with ring seals, not less than 0.64 mm (0.025 in.), meeting United States Department of Transportation Hazardous Materials Shipping Regulations, and well sealed to prevent leakage.

If a lining is used in the containers, make it of such character as to resist any action by the components.

Clearly label each container with the designation (Component A or B), type (standard or rapid), if applicable, manufacturer's name, date of manufacture, batch number (a batch shall consist of a single charge of all components in a mixing chamber), all directions for use.

Do not use any material which shows evidence of crystallization or a permanent increase in viscosity or settling of pigments which cannot be readily redispersed with a paddle.

**728.02.04 Directions for Use.** Mix when components A and B are at a temperature between 16 and 29 °C (60 and 85 °F), unless otherwise specified. Perform any heating of the adhesive components by application of indirect heat. Immediately before mixing, thoroughly mix each component with a paddle. Use separate paddles to stir each component. Immediately before use, thoroughly mix the 2 components together in the specified ratios. When mixed, all adhesives shall have a uniform gray color without black or white streaks. Do not add solvent to any epoxy.

After mixing, place epoxies in the work and also place any overlaying or inserted material which is to be bonded to the work by the epoxy before thickening of the epoxy has begun.

Place epoxy on surfaces free of rust, paint, grease, asphalt, and loose and deleterious material.

When epoxy is used as a binder to make epoxy concrete or mortar, thoroughly mix the 2 components of epoxy together before the aggregate is added. Unless otherwise specified, the mix proportions shall consist of 1 part of binder to approximately 4 parts of aggregate, by volume. Use clean aggregate with a moisture content of not more than 0.5% when tested by Test Method No. Nev. T112.

Prime surfaces against which epoxy concrete and mortar are to be placed with a coat of the epoxy just before placing the mortar.

TYPES OF EPOXIES

**728.03.01 Binder (Adhesive), Epoxy Resin Base.** This specification covers a 2 component, low viscosity, resin base epoxy designed primarily for use as a binder in making epoxy concretes or epoxy mortars, and in pressure grouting of cracks in concrete.

The epoxy shall conform to AASHTO M235, Type III, Grade 1, Class A, B, or C.

**728.03.02 Epoxy Resin Adhesive for Bonding New Concrete to Old Concrete.** This specification covers epoxy resin bonding systems for use in bonding fresh concrete to existing Portland cement concrete and fastening metal anchors in holes in concrete.

The epoxy is specified by the following types:

1. Type II is for use in non-load bearing applications for bonding fresh concrete to hardened concrete and shall conform to AASHTO M235 or ASTM C881, Type II, Grades 1, 2, or 3, Class A, B, or C.

2. Type IV is for use in load bearing applications in fastening metal anchors in holes in hardened concrete and shall conform to AASHTO M235 or ASTM C881, Type IV, Grade 3, Class A, B, or C.

3. Type V is for use in load bearing applications for bonding fresh concrete to hardened concrete and shall conform to AASHTO M235 or ASTM C881, Type V, Grades 1, 2, or 3, Class A, B, or C.

Use the Grade and/or Class appropriate for conditions. Manufacturers of epoxy are listed in the QPL.

**728.03.03 Rapid Set Epoxy Adhesive.** Epoxy used under this specification shall conform to AASHTO M237, Type I.

**728.03.04 Standard Set Epoxy Adhesive.** Epoxy used under this specification shall conform to AASHTO M237, Types II, or III.

**728.03.05 Epoxy Sealant for Inductive Loops.** This specification covers a high viscosity liquid epoxy formulated primarily for use in sealing inductive wire loops and leads imbedded in asphalt concrete and Portland cement concrete for traffic signal controls and vehicle counters. Also use this epoxy for repair work on existing spalls, cracks, and other deformations in and around saw cuts housing inductor loops and leads.

(a) Composition.

**Component A**

| | Parts by Mass |
|---|---|
| Epoxy Resin [1] | 85.00 |
| Orthocresol Glycidyl Ether [2] | 15.00 |
| Titanium Dioxide, ASTM D476, Type III or IV | 2.00 |
| Colloidal Silica [3] | 1.50 |
| Glycerine, ASTM D1257 | 0.50 |
| Silicone Anti-Foam, Type Q | 0.01 |

**Component B**

| | Parts by Mass |
|---|---|
| High Functionality Polymercaptan Hardener [4] | 40.00 |
| N-Aminoethyl Piperazine [5] | 10.00 |
| 2, 4, 6-Tri (Dimethylaminomethyl) Phenol [6] | 4.00 |
| Polysulfide Polymer [7] | 48.94 |
| Colloidal Silica [3] | 1.00 |
| Glycerine, ASTM D1257 | 0.50 |
| Carbon Black [8] | 0.10 |
| Silicone Anti-Foam, Type Q | 0.01 |

[1] Di glycidyl ether of bisphenol A, viscosity, 10.0-16.0 Pa•s (100-160 poise) at 25 °C (77 °F), epoxide equivalent 180-200. Color, Gardner 1933, 3 max.

[2] Viscosity at 25 °C (77 °F), 0.005-0.01 Pa•s (5-10 centipoise), mass 1.08-1.09 kg/L (9.00-9.10 lb/gal). Epoxide equivalent 180-200.

[3] $SiO_2$ (moisture-free basis), 99% min.; refractive index, 1.46; surface area 175-225 $m^2/g$; particle size 0.015 μm; pH (4% aqueous dispersion), 3.5-4.2; pour density, 37 $kg/m^3$ (2.3 $lb/ft^3$) max.; free moisture at 105 °C (221 °F), 1.0% max.

[4] Liquid polymercaptan resin, viscosity 10.0-13.0 Pa•s (100-130 poise) at 25 °C (77 °F); specific gravity 1.14-1.16; mercaptan value, 3.6 meq./g. Color, Gardner 1933, 1. Infrared curve shall match the curve on file with the Department.

[5] Color (APHA) 50 max.; amine value 1250-1350 based on titration which reacts with the 3 nitrogens in the molecule; appearance clear and substantially free of suspended matter.

[6] Formula weight 265; specific gravity at 25 °C (77 °F), 0.973; refractive index 1.514 at 25 °C (77 °F); distillation range 96% at 130 °C to 160 °C (266 °F to 320 °F) [0.5-1.5 mm.]; flash point, Tag. open cup, 149 °C (300 °F) min.; water content 0.06% max.

[7] Specific gravity, 1.24-1.30 at 20 °C (68 °F); viscosity, 0.7-1.2 Pa•s (700-1,200 centipoise), Brookfield at 25 °C (77 °F); pH water extract, 6.0-8.0; moisture content, 0.1% max.; pour point, –26 °C (–15 °F); average molecular weight, 1000; flash point, Cleveland Open Cup, 199 °C (390 °F) min.; sulfur content, 36-40%; color, Hellige, 9-12. The product shall be a difunctional mercaptan made from 98 mole % of bis (2-chloroethyl) formal and 2 mole % of trichloropropane.

[8] Surface area, 80-150 $m^2/g$; particle diameter, 18-30 nm; pH, 7.0-8.5; fixed carbon (moisture free), 96-98%; volatile matter, 1-4%; oil absorption, stiff paste endpoint, 0.75-0.90 CCS/g.

(b) Tests. Perform tests according to Test Method No. Nev. T501.

(c) Characteristics of Components.

**Component A**

| | |
|---|---|
| Viscosity, Pa•s (poise) at 25 °C (77 °F), Brookfield | 10-25 (100-250) |
| Shear Ratio | 2.0 Min. |

**Component B**

| | |
|---|---|
| Viscosity, Pa•s (poise) at 25 °C (77 °F), Brookfield | 10-25 (100-250) |
| Shear Ratio | 1.8 Min. |

Infrared curves of the vehicle components shall match those on file with the Department.

(d) Characteristics of Combined Components.

| | |
|---|---|
| Gel Time | 13-18 minutes on 3 mm (1/8 in.) cast sheet, cured 18 hours at 25 °C (77 °F) + 5 hours at 70 °C (158 °F) |
| Tensile Strength, MPa (psi) | 2.7 (400) Min. |
| Elongation, % | 90 Min. |
| Shore D Hardness | 45 Min. |

Color to range from Color No. 26081 to Color No. 26173 in Table VII of Federal Standard No. 595B.

(e) Directions for Use. Mix one part by volume of Component A to one part by volume of Component B. Use material within 10 minutes from the time mixing operations are started.

# SECTION 729

## TRAFFIC PAINT

SCOPE

**729.01.01 Material Covered.** These specifications cover ready mixed traffic marking paint to be applied to either asphaltic or Portland cement concrete pavements.

REQUIREMENTS

**729.02.01 General.** Provide paint free from foreign materials, such as dirt, sand, fibers from bags, or other material capable of clogging screens, valves, pumps, or other equipment used in a paint striping apparatus.

Grind the paint pigment and properly disperse in the vehicle. The dispersions shall be of such nature that the pigment does not cake or thicken in the container, and does not become granular or curdled. Any settlement of pigment in the paint shall be a thoroughly wetted, soft mass permitting the complete and easy vertical penetration of a paddle. Settled pigment shall be easily redispersed, with minimum resistance to the sideways manual motion of the paddle across the bottom of the container, to form a smooth uniform product of the proper consistency.

The specified amounts and materials used in each formula for achieving satisfactory pigment wetting and suspension, may be varied or changed to suit the vendor's method of manufacture. Paint made with any deviations in antisettling, wetting agents, or stablizers shall still be required to conform to the characteristics of the finished paint and all other requirements of these specifications.

**729.02.02 Packaging.** Prepare manufactured paint at the factory ready for application. Do not add thinner or other material to the paint after the paint has been shipped.

All shipping containers must comply with Department of Transportation Code of Federal Regulations, Hazardous Materials Regulations Board, Reference 49 CFR.

Properly seal all containers with suitable gaskets and which show no evidence of leakage.

Label all containers of paint showing the exact title of the specification, manufacturer's name, date of manufacture, and manufacturer's batch number.

Show precautions concerning the handling and application of paint on the label of the paint container.

The lining of the containers shall be of such character as to resist the solvent of this paint and to prevent skins being loosened into the body of the paint.

**729.02.03 Certificates.** Ship the material to the job site in containers that are substantial and plainly marked with the manufacturer's name and address, the color of the material, date of manufacture, and batch number.

The material manufacturer shall furnish a notarized certification that the material complies with the provisions of this specification. It shall not be inferred that the provisions of a certification of compliance waives Department inspection, sampling, or testing.

PHYSICAL PROPERTIES AND TESTS

**729.03.01 Sampling and Testing.** Samples will be taken after delivery.

The Department reserves the right to have an inspector present to observe the manufacturing process. Furnish a complete formulation record of the manufacturing process to the Materials Division. Tests will be performed according to ASTM, Federal Test Method Standards No. 141 and methods designated by the Materials Division of the Department.

**729.03.02 Materials.** The raw materials for use in the paint formula shall conform to the specifications designated by Federal serial number or paint material code number hereinafter specified. Subsequent amendments to the specifications quoted shall apply to all raw materials and finished products.

Paint shall also comply with the paint formulation requirements of the appropriate Subsections below.

**729.03.03 Epoxy Paint Marking Material.** Use epoxy paint formulations listed in the QPL.

1. Formulation. The epoxy paint marking material shall consist of a 100% solid two-part system formulated and designed to provide a simple volumetric mixing ratio of two components (e.g. two volumes of Part A to one volume Part B).

2. Composition. The component A shall be within the following limits:

| | White | Yellow | Organic Yellow |
|---|---|---|---|
| **Pigments** | | | |
| Titanium Dioxide, ASTM D476 Type II or III | 18-25% | — | 16-25% |
| Chrome Yellow, ASTM D211 Type III | — | 23-30% | 5-9% |
| **Binder** | | | |
| Epoxy Resin | 75-82% | 70-77% | 70-75% |

3. Epoxide Number. The epoxy number of the epoxy resin shall be 0.40 ± 0.1 as determined by ASTM D1652 for both white and yellow Component A on a pigment free basis.

4. Amine Number. The amine number of the curing agent (component B) shall not be less than 400 as per ASTM D2074.

5. Toxicity. Upon heating to application temperature, the material shall not exude fumes which are toxic or injurious to persons or property.

6. Viscosity. Formulations of each component shall be such that the viscosity of both components shall coincide, within 10%, at a recommended spray temperature. Component B shall be formulated so as to have a steady and constant viscosity at temperatures recommended for spray application.

7. Color and Weather Resistance. The mixed epoxy compound, both white and yellow, when applied to 75 x 150 mm (3 x 6 in.) aluminum panels at 380 µm ± 25 µm (15 mils ± 1 mil) in thickness with no glass beads and exposed in a Q.U.V. Environmental Testing Chamber as described in ASTM G154, shall conform to the following requirements. (The test shall be conducted for 75 hours at 50 °C (122 °F), 4 hours humidity and 4 hours U.V., in alternating cycles. The prepared panels shall be cured at 25 °C (77 °F) for 72 hours before exposure). The color of the white epoxy paint system shall not be darker than Federal Standard Color No. 17778 as shown in Table VIII of Federal Standard No. 595B. The color of the yellow epoxy system shall be reasonably close to Federal Standard Color No. 13538 as shown in Table IV of Federal Standard No. 595B. The gloss values of both samples shall not be less than 70 (prism geometry of 60) after the test.

8. Drying Time. The epoxy paint pavement marking material, when mixed in the proper ratio and applied at 380 µm ± 13 µm (15 mils ± 0.5 mil) wet film thickness at 25 °C ± 1 °C (77 °F ± 2 °F) and with the proper saturation of glass spheres, shall exhibit no tracking time when tested according to ASTM D711 in less than 45 minutes.

9. Curing. The epoxy paint materials shall be capable of fully curing under a constant surface temperature of 4 °C (40 °F) or above.

10. Adhesion to Concrete. The catalyzed epoxy paint pavement marking materials, when tested according to ACI Method 503, shall have such adhesion to the concrete surface that there shall be a 100% concrete failure in the performance of this test. The concrete specimens for the test shall be equivalent to Portland Cement Concrete Pavement per Section 409 with a minimum Compressive strength of 28 MPa (4,000 psi). The prepared specimens shall be conditioned at 25 °C ± 1 °C (77 °F ± 2 °F) for a minimum of 24 hours and a maximum of 72 hours before the performance of the tests indicated.

11. Hardness. The epoxy paint pavement marking materials, when tested according to ASTM D2240, shall have a Shore D Hardness greater than 75. Samples shall be allowed to cure at 25 °C ± 1 °C (77 °F ± 2 °F) for a minimum of 24 hours and a maximum of 72 hours before performing the indicated test.

12. Abrasion Resistance. The abrasion resistance shall be evaluated on a Taber Abrader with a 1,000 gram load and CS-17 wheels. The duration of test shall be 1,000 cycles. The wear index for the catalyzed material shall not be more than 80 as calculated based on ASTM D4060. The tests shall be run on cured samples of material which have been applied at a film thickness of 380 µm ± 13 µm (15 mils ± 0.5 mil). The samples shall be allowed to cure at 25 °C ± 1 °C (77 °F ± 2 °F) for a minimum of 24 hours and a maximum of 72 hours before performing the indicated tests.

13. Tensile Strength. When tested according to ASTM D638, the epoxy paint pavement marking materials shall have a tensile strength of not less than 41 MPa (6,000 psi). The Type IV Specimens shall be cast in a suitable mold and pulled at a rate of 6 mm (1/4 in.) per minute by a suitable dynamic testing machine. The samples shall be allowed to cure at 25 °C ± 1 °C (77 °F ± 2 °F) for a minimum of 24 hours and a maximum of 72 hours before performing the indicated tests.

14. Compressive Strength. When tested according to ASTM D695, the catalyzed epoxy paint pavement marking materials shall have a compressive strength of not less than 83 MPa (12,000 psi). The cast sample shall be conditioned at 25 °C ± 1 °C (77 °F ± 2 °F) for a minimum of 72 hours before performing the indicated tests. The rate of compression of these samples shall be no more than 6 mm (1/4 in.) per minute.

15. Infrared Spectra Comparison. The infrared spectrum of each component shall correlate a minimum of 92% with the reference infrared spectrum on file with the Department's Materials Division.

**729.03.04 Waterborne Paint Marking Material.** Use waterborne paint formulations listed in the QPL.

1. Scope and Classification.

a. Scope. This specification covers the specific requirements for rapid dry, high performance 100% acrylic waterborne white and yellow traffic line marking paint for application on Portland cement concrete and bituminous pavements. It shall be easily and uniformly applicable with mechanical airless or air assisted spray marking equipment at paint temperatures up to 38 °C (100 °F). The paint shall serve as a binder for glass beads in such a manner as to produce maximum adhesion and reflection.

b. Classification. Furnish the paint as Type I or Type II as specified in the proposal.

2. Quality Assurance Provisions.

a. Products Listed in the QPL. Preliminary samples from the manufacturer need not be submitted for formulations listed in the QPL.

b. Products Not Listed in the QPL. Submit a 3.8 L (1 gal) preliminary sample from the manufacturer of the intended white and yellow formulations to the Engineer for approval at least 20 days before any paint is delivered to field locations. Furnish the batch formulation which will be used in manufacturing of the paint, a test report, Material Safety Data Sheet, and all product specification data along with the preliminary sample.

The Engineer will forward the preliminary sample and required documentation to the Headquarters Materials Division. The Materials Division will verify that the formulations meet the specifications and develop baseline requirements for subsequent paint shipment to field locations.

3. Sampling and Testing. Take samples after delivery. Any water added to the containers by the manufacturer shall be considered part of the formulation and shall be mixed with the paint after delivery and before sampling.

The Department reserves the right to have an inspector present to observe the manufacturing process. Also, the Department reserves the right to require test reports of samples delivered to field locations from the manufacturer.

4. Composition Requirements.

a. Materials. The nonvolatile portion of the vehicle shall be composed of a 100% acrylic resin as determined by infrared spectral analysis.

b. Acrylic Emulsion. The acrylic emulsion shall be one of the approved acrylic emulsions listed in the QPL.

Other acrylic emulsions may be submitted for approval if the following requirements are met:

(1) The proposed emulsion is chemically and physically equal to the approved acrylic emulsions.

(2) The paint formulated with the proposed acrylic emulsion will perform equal or better than the paints formulated with the approved acrylic emulsions.

c. Performance Equality Requirements. Performance equality must be verified by comparative road service tests between the paint formulated with the approved and proposed acrylic emulsions on both asphalt and concrete surfaces. The Contractor or a third party may conduct road tests. However, the submission of the required test data is the responsibility of the Contractor. Road test shall include:

(1) Auto—No Track Time.

(2) Appearance.

(3) Durability.

(4) Night Visibility or Retroreflectivity.

d. Alternate Paint Formulation Requirements. Paint formulated using an alternative acrylic emulsion must meet all the specifications for waterborne traffic paint. Also, alternative paint formulations require approval by the Department prior to their use.

e. Prohibited Material. The manufacturer shall certify that the product does not contain mercury, lead, hexavalent chromium, toluene, chlorinated solvents, hydrolyzable chlorine derivatives, ethylene based glycol ethers and their acetates, nor any carcinogen, as defined in 29 CFR 1910.1200. When tested as specified in 7a, the lead content shall not exceed 0.06% by weight of the dry film and the test for chromium content shall be negative.

5. Quantitative Requirements of Mixed Paint. The paints shall meet the quantitative requirements specified in Table I.

**TABLE I—QUANTITATIVE REQUIREMENTS**

| Requirement Number | Requirement | White | Yellow |
|---|---|---|---|
| 1 | Pigment: Percent by weight | 62.0 ± 2 | 62.0 ± 2 |
| 2 | Total Solids: Percent by weight, minimum | 77.0 | 77.0 |
| 3 | Nonvolatile Vehicle: Percent by weight vehicle, minimum | 40.0 | 40.0 |
| 4 | Consistency: Krebs-Stormer Shearing rate 200 rpm, Equivalent K.U. | 80-95 | 80-95 |
| 5 | Density: kilogram/Liter (lb/gal), minimum | 1.65 (13.75) | 1.60 (13.35) |
| 6 | Fineness of Grind: Hegman gauge, North Standard Scale, minimum | 3 | 3 |
| 7 | Drying Time, No-Pick-Up: Minutes, maximum | 7 | 7 |
| 8 | Directional Reflectance: minimum | 89 | 58 |
| 9 | Volatile Organic Content, VOC: g/L (lb/gal), maximum | 150 (1.25) | 150 (1.25) |
| 10 | Dry-Through, Early Washout: Minutes | <125 | <125 |
| 11 | Dry Opacity, Type I: minimum<br>Dry Opacity, Type II: minimum | 0.92<br>0.95 | 0.92<br>0.95 |
| 12 | Bleeding Ratio: minimum, 125 μm (5 mils) wet | 0.97 | 0.97 |
| 13 | Total Solids: Percent by volume, minimum | 60 | 58 |
| 14 | Wet Opacity: minimum, 125 μm (5 mils) wet | 0.90 | 0.90 |
| 15 | Mud Cracking at 1.52 mm (60 mils) wet, For Type II Paints Only | PASS | PASS |

6. Requirements of Mixed Paint.

a. Condition in Container. When tested, as specified in subparagraph 7b, the paint, as received, shall show no evidence of biological growth, corrosion of the container, livering or hard settling. The paint shall be dispersible by hand stirring for 5 minutes to a smooth and homogeneous consistency, exempt of gel structures, persistent foam or air bubbles.

b. Appearance. When tested as specified in subparagraph 7c, the paint shall produce a film which is smooth, uniform, free from grit, undispersed particles, craters and pinholes.

c. Accelerated Package Stability. After storage as specified in subparagraph 7d, the sample shall conform to the requirements of subparagraphs 6a and 6b. The sample shall show no change in consistency greater than 5 K.U. from the value in Table I.

d. Flexibility. When tested as specified in subparagraph 7e, the paint shall not crack, chip, or flake after the test panel is bent 180 degrees over a 13 mm (1/2 in.) mandrel.

e. Water Resistance. When tested as specified in subparagraph 7f, the paint film shall not soften, blister, wrinkle, lose adhesion, change color, or show other evidence of deterioration.

f. Freeze-Thaw Stability. When tested as specified in subparagraph 7h, the paint shall show no coagulation of flocculation, change in consistency greater than 10 K.U. from the value in Table I, nor a decrease in scrub resistance by more than 10% of the requirement in subparagraph 6m.

g. Color Requirements.

(1) Color Match. For all colors except white and yellow, when tested as specified in subparagraph 7i(3), the paint shall match the specified Federal Standard 595B color number within _E of 6.0 CIELAB units.

(2) Daylight Directional Reflectance. When tested as specified in subparagraph 7i(2), the white paint shall have the daylight directional reflectance specified in Table I.

(3) Yellow Color Match. The yellow traffic paint shall be an approximate color match to Federal Standard 595B color number 33538 when tested according to subparagraph 7i(4).

h. Heat-Shear Stability. When tested as specified in subparagraph 7m, the sample shall not show signs of gelling or other instability. The consistency shall be in compliance with Table I.

i. Skinning. The paint shall not skin when tested as specified in subparagraph 7n.

j. Dry-Through, Early Washout. The paint, when tested as specified in subparagraph 7o, shall have a dry-through time less than 125 minutes.

k. Abrasion Resistance. When tested as specified in subparagraph 7g, both baked and weathered paint films shall require not less than 150 liters (40 gal) of sand to abrade the paint film through to the substrate.

l. Accelerated Weathering. When tested as specified in subparagraph 7j, the colored samples after weathering shall be in conformance with subparagraph 6g.

The directional reflectance of white paint shall meet the requirement in Table I.

After performing the scrub resistance test according to subparagraph 7l, the paint shall be in conformance with subparagraph 6m.

m. Scrub Resistance. When tested as specified in subparagraph 7l, it shall not take less than 500 cycles to remove the paint film.

n. Titanium Dioxide Content. When tested according to subparagraph 7p, the yellow colored paint shall contain a maximum of 23.7 g/L (0.20 lb/gal) Rutile titanium dioxide.

The white paint shall contain a minimum of 120 g/L (1.00 lb/gal) Rutile titanium dioxide.

o. Wet Opacity. The paint when tested as specified in 7q, shall have a wet opacity of 0.90.

p. Mud Cracking, Type II Paint Only. The paint when tested as specified in 7r, shall not contain any cracks.

q. Dry to No Pick Up. When applied at ambient temperature of 10 to 38 °C (50 to 100 °F), the paint shall dry to a no pick up condition under traffic when applied at 380 µm ± 25 µm (15 mils ± 1 mil) wet film thickness in 40 to 90 seconds.

r. Material Safety Data Sheet. Submit a Material Safety Data Sheet (MSDS) according to FED-STD-313 unless otherwise specified.

7. Test Methods. Samples will be tested as specified in the following Table II. Unless otherwise specified, tests will be performed at standard conditions, which are 25 °C ± 1 °C (77 °F ± 2 °F) and 50% ± 5% relative humidity. Test results will be evaluated for conformance to requirements. The sample shall be unacceptable if any test result is not in conformance with the corresponding requirements in subparagraph 6 and Table I.

**TABLE II—TEST METHODS**

| Characteristic | Requirement Subparagraph | FED-STD 141 | ASTM Method | Test Subparagraph |
|---|---|---|---|---|
| Lead Content | 4e | — | D3335 | 7a(1) |
| Chromium Content | 4e | — | D3718 | 7a(2) |
| Condition in Container | 6a | — | — | 7b |
| Appearance | 6b | — | — | 7c |
| Accelerated Package Stability | 6c | — | D1849 | 7d |
| Flexibility | 6d | — | D522 | 7e |
| Water Resistance | 6e | — | — | 7f |
| Freeze-Thaw Stability | 6f | — | D2243 | 7h |
| Color | 6g | — | D2244 | 7i |
| Directional Reflectance | 6g(2) | — | E1347 | 7i(2) |
| Yellow Color Match | 6g(3) | — | D1729 | 7i(4) |
| Heat-Shear Stability | 6h | — | — | 7m |
| Skinning | 6i | — | — | 7n |
| Dry-Through, Early Washout | 6j | 3021 | D1640 | 7o |
| Abrasion Resistance | 6k | — | D968 | 7g |
| Accelerated Weathering | 6l | — | G154 | 7j |
| Scrub Resistance | 6m | 2013 | D2486 | 7l |
| Volatile Organic Content | Table I | — | D3723 | — |
| Nonvolatile Vehicle | Table I | — | D2369 | — |
| Consistency | Table I | — | D562 | — |
| Total Solids by Weight | Table I | — | D3723 | — |
| Dry Opacity | Table I | — | — | 7k |
| Dry Time, No-Pick-Up | Table I | 4121 | D711 | — |
| Fineness of Dispersion | Table I | — | D1210 | — |
| Bleeding Ratio | Table I | — | D969 | — |
| Pigment, % by Mass | Table I | — | D3723 | — |
| Titanium Dioxide | 6n | — | D1394 | 7p |
| Density | Table I | — | D1475 | — |
| Wet Opacity | Table I | — | — | 7q |
| Mud Cracking, Type II Paint Only | Table I | — | — | 7r |

a. Prohibited Materials. Lead-Free Yellow and White.

(1) Lead Content. Determine lead according to ASTM D3335 or by the use of an x-ray fluorescence spectrometer according to the manufacturer's manual. The x-ray method shall be used in case of dispute. Evaluate for compliance with subparagraph 4e.

(2) Chromium (Hexavalent) Content. Add 5 mL (0.17 ounce) of 25% aqueous KOH to 0.5 g (8 grains) of the extracted pigment contained in a centrifuge tube. Agitate by shaking and centrifuge. A yellow color in the supematant liquid indicates the presence of hexavalent chromium. If the results of the above test are inconclusive, then use the procedure in ASTM D3718 to test for chromium content. Evaluate results for compliance with subparagraph 4e.

b. Condition in Container. Before stirring the contents of the container in which the material was originally packaged, check for evidence of biological growth and corrosion. Then lower a spatula into the container and determine whether the paint has livered or developed hard settling. Disperse the paint with the spatula for 5 minutes and examine for compliance with subparagraph 6a.

c. Appearance. Draw down the paint on a clear glass panel to a wet film thickness of 0.33 mm (0.013 in.), and allow to dry for 24 hours at standard conditions. Evaluate for conformance with subparagraph 6b.

d. Accelerated Package Stability. Fill a 473 mL (1 pint) resin-lined friction-top can with the sample. Ensure that the bulk sample from which the cans are filled is well stirred and uniform, that the containers used are clean, and that the lids are applied promptly to the cans to prevent evaporation losses. Store at a temperature of 52 °C (126 °F) for 2 weeks. Evaluate following the procedure in ASTM D1849, except allow hand stirring for 5 minutes to ensure uniform distribution. Evaluate the consistency for conformance with Table I. Draw down the paint as in subparagraph 7c. Evaluate for conformance with subparagraph 6c.

e. Flexibility. Determine flexibility according to Method B of ASTM D522. Draw down the paint to a wet film thickness of 0.13 mm (0.005 in.) on clean bare cold rolled steel panel. Air dry the panel for 24 hours at standard conditions, then bake for 5 hours at 105 °C ± 2 °C (221 °F ± 4 °F), and finally condition the panel for 30 minutes at standard conditions. Bend over a 13 mm (1/2 in.) diameter cylindrical mandrel and examine under a magnification of 7 diameters for compliance with subparagraph 6d.

f. Water Resistance. Prepare a 10 x 15 cm (4 x 6 in.) concrete panel as specified in Method 2051 Procedure B of Fed. Test Method Standard No. 141. Draw down the paint to a wet film thickness of 0.33 mm (0.013 in.), and allow to dry in a horizontal position at standard conditions for 24 hours. Immerse one-half of the painted panel in distilled water at 25 °C ± 1 °C (77 °F ± 2 °F). After 18 hours, remove the panel from the water and allow it to dry for two hours at standard conditions. Evaluate for conformance with subparagraph 6e.

g. Abrasion Resistance.

(1) Sample Preparation. Draw down the paint on 4 glass panels measuring approximately 100 x 200 mm (4 x 8 in.) to a dry film thickness of 0.102 to 0.107 mm (4 to 4.2 mils).

(2) Baked Films. Air dry two of the panels for 24 hours at standard conditions and then bake for 5 hours at 105 °C ± 2 °C (221 °F ± 4 °F). After baking, condition the panels for 30 minutes at standard conditions and then run the abrasion test as specified in subparagraph 7g(4).

(3) Weathered Films. Air dry the other two panels for 48 hours at standard conditions. Then subject the panels to accelerated weathering according to subparagraph 7j. Remove the panels and condition for 24 hours at standard conditions, and then run the abrasion test as specified in subparagraph 7g(4).

(4) Test. Subject the panels to the abrasion test according to ASTM D968, Method A, except that the inside diameter of the metal guide tube shall be from 18.97 to 19.05 mm (0.74 to 0.75 in.). Five liters (1.3 gal) of unused sand shall be used for each test panel. The test shall be run on two test panels. Five liters (1.3 gal) of sand is approximately 7.94 kg (17.5 lb). Evaluate for compliance with subparagraph 6k.

h. Freeze-Thaw Stability. Test according to ASTM D2243 for 3 freeze-thaw cycles. Perform the consistency test according to ASTM D562 and the scrub resistance test as described in subparagraph 7l. Check for conformance with subparagraph 6f.

i. Color.

(1) Sample Preparation. Use the test panels prepared for the accelerated weathering test subparagraph 7j(1).

(2) Daylight Directional Reflectance. For the white paint, determine the directional reflectance before and after weathering according to ASTM E1347. Evaluate for conformance with Table I.

(3) Color Match. For colors other than white and yellow, determine the color difference of the paint before and after weathering according to ASTM D2244 using CIE Illuminant D65 with the 10 degree standard observer. Evaluate for conformance with subparagraph 6g.

(4) Yellow Color Match. Determine the color match for yellow paint before and after weathering according to ASTM D1729 with the daylight illumination represented by CIE Illuminant D75 or D65. Evaluate for conformance with subparagraph 6g(3).

j. Accelerated Weathering.

(1) Sample Preparation. Apply the paint at a wet film thickness of 0.33 mm (0.013 in.) to four 8 x15 cm (3 x 6 in.) aluminum panels prepared as described in Method 2013 of Fed. Test Method Standard No. 141. Air dry the sample 48 hours under standard conditions.

(2) Testing Conditions. Test according to ASTM G154 using both ultraviolet light (UV-BPS-40) and condensate exposure, 300 hours total, alternating 4 hour UV exposure at 60 °C (140 °F), and 4 hours condensate exposure at 40 °C (104 °F).

(3) Evaluation. Remove the samples and condition for 24 hours under standard conditions. Determine the directional reflectance and color match using the procedures in subparagraphs 7i(2) and 7i(3). Evaluate for conformance with the color requirements in subparagraph 6g. Using the procedure described in subparagraph 7l, run the scrub resistance test. Evaluate for conformance with subparagraph 6m.

k. Dry Opacity. Use Procedure B, Method B of Method 4121 of Fed. Test Method Standard No. 141. The wet film thickness shall be 0.13 mm (0.005 in.). Evaluate for conformance with Table I.

l. Scrub Resistance. Using the procedure of ASTM D2486 modified to use the 8 x 15 cm (3 x 6 in.) test panels from the accelerated weathering test, subparagraph 7j, evaluate for conformance with subparagraph 6m.

m. Heat-Shear Stability. One pint of the paint is sheared in a Waring Blender at high speed to 65 °C (149 °F). The blender should have tight fitting lid and be taped to minimize volatile loss. When the paint reaches 65 °C (149 °F), stop the blender immediately and apply cover. Let cool a minimum of 12 hours and examine for gelling or other signs of instability. Evaluate for compliance with subparagraph 6h.

n. Skinning. Place 710 mL (1.5 pints) of the paint in a 946 mL (2 pint) container, seal, and test according to Method 3021 of Fed. Test Method Standard 141. After 48 hours, examine for compliance with subparagraph 6i.

o. Dry-Through, Early Washout. Draw down the paint on a glass panel to a wet film thickness of 0.33 mm (0.013 in.). Immediately place in a humidity chamber maintained at 23 °C ± 2 °C (73 °F ± 4 °F) and 90% ± 3% relative humidity. Test according to ASTM D1640 except that the pressure exerted shall be the minimum needed to maintain contact with the thumb and film. Check for compliance with subparagraph 6j.

p. Titanium Dioxide Content. Determine the titanium dioxide content using the Aluminum Reduction Method of ASTM D1394. Evaluate for conformance with subparagraph 6n.

q. Wet Opacity. Apply a coat of water-white mineral oil (U.S.P. Liquid Petroleum, Heavy) to a wet-film thickness of 0.037 mm (0.0015 in.) over each of the dried test panels prepared for determining dry opacity, Method 4121 of Fed. Test Method Std. No. 141, Procedure B. Allow the panels to stand horizontally in a dust free atmosphere for 10 minutes at standard conditions, blot the excess oil, and perform the test.

r. Mud Cracking, Type II Paint Only. On a black-white Leneta chart, Form 2C-Opacity, draw down a stripe of paint 75 mm (3 in.) wide and at least 150 mm (6 in.) long, and having a 1.52 mm (60 mil) wet film thickness. Allow the paint to dry for 48 hours at standard conditions on a horizontal surface. After 48 hours, the paint film shall not contain any cracks.

8. Packaging.

a. Packaging, Packing, and Marking. Package, pack and mark the paint according to PPP-P-1892, unless otherwise specified.

b. Special Marking.

(1) Shipping Container Markings. Each shipping container shall be marked:

“PROTECT FROM FREEZING—STORE ABOVE 2 °C (35 °F)”

(2) Unit Container Markings. Each unit container shall be marked as follows:

“PROTECT FROM FREEZING—STORE ABOVE 2 °C (35 °F)”

“After opening, maintain a thin layer of water on surface of paint during storage to prevent skinning.”

“Use only in equipment designed for water based paints.”

"This paint may be reflectorized by dropping glass beads conforming to Nevada Department of Transportation (NDOT) specifications onto the wet paint. The surface to be coated shall be free from dirt, oil, grease, other contaminants, and loose, peeling, or poorly bonded paint. The paint shall be applied to the surface at a wet film thickness of 0.41 mm (0.016 in.) minimum for Type I or 0.64 mm (0.025 in.) minimum for Type II, while air and surface temperatures are above 7 °C (45 °F) and rising."

**729.03.05 Polyurea Paint Marking Material.** Use polyurea paint formulations listed in the QPL.

1. Formulation. The material shall consist of a 100% solid plural component system formulated and designed to provide a simple volumetric mixing ratio of two components (e.g. two or three volumes of Part A to one volume Part B), that is free from heavy metals.

2. Toxicity. Upon heating to application temperature, the material shall not exude fumes that are toxic or injurious to persons or property.

3. Viscosity. Formulations of each component shall be such that the viscosity of both components shall coincide, within 10%, at a recommended spray temperature. Component B shall be formulated so as to have a steady and constant viscosity at temperatures recommended for spray application.

4. Colors and Weather Resistance. The mixed material, white, yellow or black, when applied to 75 x 150 mm (3 x 6 in.) aluminum panels at 380 µm ± 25 µm (15 mils ± 1 mil) in thickness with no glass beads and exposed in a Q.U.V. Environmental Testing Chamber as described in ASTM G154, shall conform to the following requirements. (The test shall be conducted for 75 hours at 50 °C (122 °F), 4 hours humidity and 4 hours U.V., in alternating cycles. The prepared panels shall be cured at 25 °C (77 °F) for 72 hours before exposure). The color of the white polyurea paint system shall not be darker than Federal Standard Color No. 17778 as shown in Table VIII of Federal Standard No. 595B. The color of the yellow polyurea system shall be reasonably close to Federal Standard Color No. 13538 as shown in Table IV of Federal Standard No. 595B. The color of the black polyurea paint marking material shall be reasonably close to Federal Standard Color No. 37038 as shown in Federal Standard No. 595B. The gloss values of both white and yellow samples shall not be less than 70 (prism geometry of 60) after the test.

5. Drying Time. When mixed in the proper ratio and applied at 380 µm ± 13 µm (15 mils ± 0.5 mil) wet film thickness at 25 °C ± 1 °C (77 °F ± 2 °F) and with the proper saturation of glass spheres, the material shall exhibit no tracking time when tested according to ASTM D711 in less than 10 minutes.

6. Curing. The material shall be capable of fully curing under a constant surface temperature of 4 °C (40 °F) or above.

7. Adhesion to Concrete. When tested according to ACI Method 503, the material shall have such adhesion to the concrete surface that there shall be a 100% concrete failure in the performance of this test. The concrete specimens for the test shall be equivalent to Portland Cement Concrete Pavement per Section 409 with a minimum compressive strength of 28 MPa (4,000 psi). The prepared specimens shall be conditioned at 25 °C ± 1 °C (77 °F ± 2 °F) for a minimum of 24 hours and a maximum of 72 hours before the performance of the tests indicated.

8. Hardness. When tested according to ASTM D2240, the material shall have a Shore D Hardness greater than 70. Samples shall be allowed to cure at 25 °C ± 1 °C (77 °F ± 2 °F) for a minimum of 24 hours and a maximum of 72 hours before performing the indicated test.

9. Abrasion Resistance. The abrasion resistance shall be evaluated on a Taber Abrader with a 1,000 gram load and CS-17 wheels. The duration of test shall be 1,000 cycles. The weight loss for the catalyzed material shall be not more than 120 mg as calculated based on ASTM D4060. The tests shall be run on cured samples of material, which have been applied at a film thickness of 380 µm ± 13 µm (15 mils ± 0.5 mil). The samples shall be allowed to cure at 25 °C ± 1 °C (77 °F ± 2 °F) for a minimum of 24 hours and a maximum of 72 hours before performing the indicated tests.

10. Tensile Strength. When tested according to ASTM D638, the material shall have a tensile strength of not less than 24 MPa (3,500 psi). The Type IV Specimens shall be cast in a suitable mold and pulled at a rate of 6 mm (1/4 in.) per minute by a suitable dynamic testing machine. The samples shall be allowed to cure at 25 °C ± 1 °C (77 °F ± 2 °F) for a minimum of 24 hours and a maximum of 72 hours before performing the indicated tests.

11. Infrared Spectra Analysis. The infrared spectrum of each component shall correlate a minimum of 92% with the reference infrared spectrum on file with the Department's Materials Division.

# SECTION 730

## TRAFFIC BEADS

### SCOPE

**730.01.01 Materials Covered.** This specification covers the quality requirements of traffic beads and reflective elements for dropping or spraying on pavement markings.

### PHYSICAL PROPERTIES AND TESTS

**730.02.01 Requirements.** Furnish certifications which shall include or have attached specific results of tests performed for roundness, refractive index, flow characteristics, and gradation. The certifications shall show the quantity and lot number.

(a) Glass Beads for Epoxy Paint. The glass spheres shall be colorless, clean, transparent, free from milkiness or excessive air bubbles, and essentially clean from surface scarring or scratching. They shall be spherical in shape and at least 70% shall be true spheres when tested according to ASTM D1155, Procedure A or Microfiche Reader method.

The moisture content of the beads shall not exceed 0.01% by mass when tested at 105 °C (221 °F) for 3 hours.

The refractive index of the spheres shall be a minimum of 1.50 as determined by the liquid immersion method at 25 °C (77 °F).

The silica content of the glass spheres shall not be less than 60%.

The glass spheres shall have the following gradation when tested according to ASTM D1214:

**Type I**

| Sieve Size | % Retained by Mass |
|---|---|
| 2.00 mm (No. 10) | 0 |
| 1.70 mm (No. 12) | 0-5 |
| 1.40 mm (No. 14) | 5-20 |
| 1.18 mm (No. 16) | 40-80 |
| 1.00 mm (No. 18) | 10-40 |
| 850 µm (No. 20) | 0-5 |
| Pan | 0-2 |

**Type II**

| Sieve Size | % Retained by Mass |
|---|---|
| 850 µm (No. 20) | 0-5 |
| 600 µm (No. 30) | 5-20 |
| 300 µm (No. 50) | 30-75 |
| 180 µm (No. 80) | 9-32 |
| Pan | 0-10 |

Glass spheres shall be coated with a silane-type adherence coating to enhance its embedment in, and adherence to, the applied binder film. The coated beads shall emit a yellow-green fluorescence when tested by the Dansyl Chloride test procedure.

Glass spheres shall be treated with a moisture-proof coating. Glass beads shall show no tendency to absorb moisture in storage and shall remain free of clusters and lumps. They shall flow freely from dispensing equipment at any time when surface and atmospheric conditions are satisfactory for marking operations. The moisture-resistance of the glass sphere shall be determined on the basis of the following test:

> Place 900 g (2 lb) of spheres in a washed cotton bag, having a thread count of 80 per 1,000 $mm^2$ (50 per $in.^2$) (warp and woof) and immerse the bag in a container of water for 30 seconds. Remove the bag and force excess water from the sample by squeezing the bag. Suspend and allow to drain for two hours at 21 to 22 °C (70 to 72 °F). Then mix the sample in the bag shaking thoroughly. Transfer a sample slowly to clean, dry glass funnel having a stem 100 mm (4 in.) in length, with a 9.5 mm (3/8 in.) inside diameter stem entrance opening and a minimum exit opening of 6 mm (1/4 in.). The entire sample shall flow freely through the funnel without stoppage. When first introduced into the funnel, if the sphere clogs, it is permissible to lightly tap the funnel to initiate the flow.

(b) Glass Beads for Waterborne Paint. The beads shall be transparent, clear colorless glass, smooth and spherically shaped, free of milkiness, pits, or excessive bubbles.

The glass beads shall have a minimum of 80% rounds per screen for the two highest sieve quantities. The remaining sieve fractions shall be no less than 75% rounds. Beads shall be tested for roundness using ASTM D1155 or the Microfiche Reader method.

The glass beads shall have no more than 3% angular particles per screen (determined visually). Angular particles are defined as particles with sharp edges.

The glass beads shall also conform to Federal Specification TT-B-1325—Beads (Glass Spheres) Retroreflective.

The moisture content of the beads shall not exceed 0.01% by mass when tested at 105 °C (221 °F) for 3 hours.

Apply an embedment coating material to the glass beads during the process of bead manufacture. The embedment coating material shall enhance the beads embedment properties in waterborne traffic paint. The beads shall be tested for an embedment coating by any approved method using Dansyl Chloride.

The glass beads shall have a refractive index of 1.50 minimum as determined by the liquid immersion method (Becke Line Method or equal) at 25 ± 5 °C (77 ± 9 °F).

When tested according to ASTM D1214, the beads delivered shall conform to the following gradation:

| Sieve Size | % Retained by Mass |
|---|---|
| 850 µm (No. 20) | 3-10 |
| 600 µm (No. 30) | 20-40 |
| 450 µm (No. 40) | 30-50 |
| 300 µm (No. 50) | 15-35 |
| 180 µm (No. 80) | 0-10 |

(c) Glass Beads for Polyurea Paint. Glass spheres shall be colorless, clean, transparent, free from milkiness or excessive air bubbles, and essentially clean from surface scarring or scratching. They shall be spherical in shape and at least 70% shall be true spheres when tested according to ASTM D1155, Procedure A or Microfiche Reader method.

The refractive index of the spheres shall be a minimum of 1.50 as determined by the liquid immersion method at 25 °C (77 °F).

The moisture content of the beads shall not exceed 0.01% by mass when tested at 105 °C (221 °F) for 3 hours.

The silica content of the glass spheres shall not be less than 60%.

The glass spheres shall have the following gradation when tested according to ASTM D1214:

| Type I | | Type II | | Type III | |
|---|---|---|---|---|---|
| Sieve Size | % Retained by Mass | Sieve Size | % Retained by Mass | Sieve Size | % Retained by Mass |
| 2.00 mm (No. 10) | 0 | 850 µm (No. 20) | 0-5 | 850 µm (No. 20) | 0 |
| 1.70 mm (No. 12) | 0-5 | 600 µm (No. 30) | 5-20 | 600 µm (No. 30) | 5-25 |
| 1.40 mm (No. 14) | 5-20 | 300 µm (No. 50) | 30-75 | 300 µm (No. 50) | 40-80 |
| 1.18 mm (No. 16) | 40-80 | 180 µm (No. 80) | 9-32 | 150 µm (No. 100) | 10-35 |
| 1.00 mm (No. 18) | 10-40 | Pan | 0-10 | Pan | 0-5 |
| 850 µm (No. 20) | 0-5 | | | | |
| Pan | 0-2 | | | | |

Glass spheres shall be coated with a silane-type adherence coating to enhance its embedment in, and adherence to, the applied binder film. The coated beads shall emit a yellow-green fluorescence when tested by the Dansyl Chloride test procedure. Glass spheres shall be treated with a moisture-proof coating. Glass beads shall show no tendency to absorb moisture in storage and shall remain free of clusters and lumps. They shall flow freely from dispensing equipment at any time when surface and atmospheric conditions are satisfactory for marking operations. The moisture-resistance of the glass spheres shall be determined on the basis of the following test:

> Place 900 g (2 lb) of spheres in a washed cotton bag, having a thread count of 80 per 1,000 $mm^2$ (50 per $in.^2$), warp and woof, and immerse the bag in a container of water for 30 seconds. Remove the bag and force excess water from the sample by squeezing the bag. Suspend and allow to drain for two hours at 21 to 22 °C (70 to 72 °F). Then mix the sample in the bag, shaking thoroughly. Slowly transfer a sample to a clean, dry glass funnel having a stem 100 mm (4 in.) in length, with a 9.5 mm (3/8 in.) inside diameter stem entrance opening and a minimum exit opening of 6 mm (1/4 in). The entire sample shall flow freely through the funnel without stoppage. When first introduced into the funnel, if the spheres clog, it is permissible to lightly tap the funnel to initiate the flow.

(d) Reflective Elements for Polyurea Paint. The bonded core elements shall be composed of a durable core having clear and/or yellow microcrystalline ceramic beads bonded to the core with a durable polymer coating.

Microcrystalline ceramic beads bonded to reflective elements shall have a minimum index of refraction of 1.8 when tested using the liquid oil immersion method.

A sample of microcrystalline ceramic and glass beads supplied by the manufacturer shall show resistance to corrosion of their surface after exposure to a 1% solution, by weight, of sulfuric acid. The 1% acid solution shall be made by adding 5.7 mL of concentrated acid into 1000 mL of distilled water. Take caution to always add the concentrated acid into the water, not the reverse.

The resistance to corrosion of the glass spheres shall be determined on the basis of the following test:

> Place 10 g of the beads in a 100 mL beaker and cover with 30 to 40 mL of the 1% sulfuric acid solution. Cover the beaker to prevent evaporation and allow the sample to be exposed for 24 hours under these conditions. Then decant the acid solution, rinse the beads with fresh DI water and dry the sample in a 66 °C (150 °F) oven for approximately 15 minutes or until the sample is dry. Microscopic examination (20X) shall show no more than 15% of the beads having a formation of a very distinct opaque white (corroded) layer on their entire surface.

# SECTION 731

## ENGINEERING FABRICS

### SCOPE

**731.01.01 Materials Covered.** Engineering fabrics shall include pavement reinforcing fabric, geotextile, geogrid, geomembrane, and any additional fabric types that may be specified in the Special Provisions.

Furnish engineering fabrics in protective opaque covers capable of protecting the fabric from ultraviolet rays, abrasion, and water. Store the engineering fabrics in accordance with the manufacturer's recommendations. If stored outdoors, fabrics shall remain covered and off of the ground.

During installation, the fabrics shall not be exposed to ultraviolet rays for more than 14 days.

### REQUIREMENTS

**731.02.01 Certificates.** Furnish a Certificate of Compliance for each type of engineering fabric used on the project according to Subsection 106.05.

### PHYSICAL PROPERTIES AND TESTS

**731.03.01 Pavement Reinforcing Fabric.** The pavement reinforcing fabric shall be constructed of a fiberglass/polymer composite and shall conform to the following:

| PROPERTY | TEST METHOD | REQUIREMENT |
|---|---|---|
| Tensile Strength, Each Direction | ASTM D6637 | 100 kN/m (560 lb/in.) Minimum |
| Elongation at Break | ASTM D6637 | < 5% |
| Melting Point | ASTM D276 | > 218 °C (> 425 °F) |
| Grid Size, Square | — | 20-25 mm (0.75-1.0 in.) |

**731.03.02 Geotextile (Class 1).** The geotextile shall be nonwoven needle-punched polypropylene fabric and shall conform to the following:

| PROPERTY | TEST METHOD | REQUIREMENT |
|---|---|---|
| Survivability | AASHTO M288 | CLASS 1 |
| Permittivity | ASTM D4491 | $\geq 0.5\ sec^{-1}$ |
| Apparent Opening Size (AOS), U.S. Sieve No. | ASTM D4751 | $100 \leq AOS \leq 60$ |
| Ultraviolet Stability @ 500 hr, Strength Retained | ASTM D4355 | ≥ 50 % |

**731.03.03 Geotextile (Class 2).** The geotextile shall be nonwoven needle-punched polypropylene fabric and shall conform to the following:

| PROPERTY | TEST METHOD | REQUIREMENT |
|---|---|---|
| Survivability | AASHTO M288 | CLASS 2 |
| Permittivity | ASTM D4491 | $\geq 0.5\ sec^{-1}$ |
| Apparent Opening Size (AOS), U.S. Sieve No. | ASTM D4751 | $100 \leq AOS \leq 60$ |
| Ultraviolet Stability @ 500 hr, Strength Retained | ASTM D4355 | ≥ 50 % |

**731.03.04 Geogrid.** The geogrid shall be single layered, biaxial, and shall be made of high density polyethylene or polypropylene. The geogrid shall be manufactured by being extruded, coextruded, or integrally formed and shall conform to the following:

| PROPERTY | TEST METHOD | REQUIREMENT |
|---|---|---|
| Aperture Size Range | I.D. Callipered | 25-50 mm (1-2 in.) |
| Rib Shape | Visual Observation | Rectangular or Square |
| Tensile Strength @ 5% Strain, Cross Direction | ASTM D6637 | 11.4 kN/m (780 lb/ft) Minimum |
| Tensile Strength @ 5% Strain, Machine Direction | ASTM D6637 | 19.0 kN/m (1300 lb/ft) Minimum |

**731.03.05 Geomembrane.** The geomembrane shall be impermeable and made of smooth high density polyethylene and shall conform to the following:

| PROPERTY | TEST METHOD | REQUIREMENT |
|---|---|---|
| Sheet Thickness | ASTM D5199 | 1.0 mm (40 mil) Minimum |
| Density | ASTM D1505 | 0.94 g/cm$^3$ (58 lb/ft$^3$) Minimum |
| Tensile Strength at Yield | ASTM D638 | 15 kN/m (84 lb/in.) Minimum |
| Tear Resistance | ASTM D1004 | 125 N (28 lb) Minimum |
| Puncture Resistance | ASTM D4833 | 320 N (72 lb) Minimum |

# SECTION 732

## PAVEMENT MARKING FILM

SCOPE

**732.01.01 Material Covered.** This specification covers the quality requirements for pavement marking tape and thermoplastic marking material.

REQUIREMENTS

**732.02.01 Certificates.** Furnish a Certificate of Compliance for the pavement marking film according to Subsection 106.05.

PHYSICAL PROPERTIES AND TESTS

**732.03.01 Pavement Marking Tape (Type 1).** Type 1 marking tape shall conform to ASTM D4505; Reflectivity Level II; Adhesive Class 1, 2, or 3; Skid Resistance Level A. Use Type 1 pavement marking tape listed in the QPL.

**732.03.02 Pavement Marking Tape (Type 2).** Type 2 marking tape shall conform to ASTM D4505; Reflectivity Level II; Adhesive Class 1, 2, or 3; Skid Resistance Level B. Use Type 2 pavement marking tape listed in the QPL.

**732.03.03 Pavement Marking Tape (Type 4).** Type 4 marking tape shall conform to ASTM D4505; Reflectivity Level I; Adhesive Class 1, 2, or 3; Skid Resistance Level A. Use Type 4 pavement marking tape listed in the QPL.

**732.03.04 Thermoplastic.** Use thermoplastic listed in the QPL.

(a) Hot Applied Thermoplastic. Hot applied thermoplastic marking material shall conform to AASHTO M249 except as modified by the following:

1. In paragraph 3.1.2 of AASHTO M249, add the following:

   The resin shall be composed of alkyd resins wherein a minimum of 70% by mass of the combined resin, filler, and pigment shall be modified glycerol ester of rosin.

2. In paragraph 4.3 of AASHTO M249 add the following physical characteristics:

   The infrared spectra of the extracted resin will be compared to the characteristic absorption bands of maleic modified glycerol ester of rosin.

3. In paragraph 4.3.1 of AASHTO M249, add the following:

   The yellow color may also conform to Federal Test Standard No. 595B, Color No. 13655.

   The material shall be capable of being applied at a temperature between 190 °C to 230 °C (375 °F to 450 °F) and to the required thickness without excessive overspray, running, or deformation of the edges. The marking compound shall contain glass beads and shall have a top dressing of glass beads applied. The thermoplastic material shall be capable of bearing traffic within 5 minutes after application and show no deformation or flaking at temperatures between –23 °C to 60 °C (–10 °F to 140 °F).

(b) Preformed Thermoplastic. The preformed thermoplastic material shall conform to the following:

1. Composition. The thermoplastic material shall conform to AASHTO M249 with the exception of the relevant differences due to the material being preformed, and the following specifications. The preformed thermoplastic pavement markings shall consist of a homogeneous mixture of resins, fillers, pigments, and glass beads. The resin shall be the alkyd type thermoplastic composed of a modified ester rosin. The infrared spectra of the extracted resin will be compared to the characteristic absorption bands of maleic modified glycerol ester of rosin.

2. Glass Beads. The markings shall contain a minimum of 30% glass spheres which shall conform to AASHTO M247, Type 1, except that glass spheres shall have a minimum of 70% true spheres on each sieve and 80% true spheres overall.

3. Reflectivity Retention. The glass beads shall be homogeneously blended throughout the material with a securely bonded protruding exposed layer of beads that provide immediate retroreflectivity. No additional glass beads shall be needed to be dropped on the material during application to obtain the necessary retroreflectivity.

4. Retroreflectivity. The preformed markings shall upon application exhibit uniform adequate nighttime retroreflectivity. At 86° 30' incidence angle and 1° 30' divergence angle, the markings shall have average minimum intensities of 300 millicandelas for white and 170 millicandelas for yellow as measured with an approved retroreflectometer listed in the Subsection 632.02.05 of the QPL.

5. Color Characteristics. The thermoplastic material without glass beads shall meet the following:

   White: Daylight reflectance at 45°/0° of 75% minimum.

   Yellow: Daylight reflectance at 45°/0° of 45% minimum.

   The daylight reflectance shall not change significantly when the preformed thermoplastic is properly applied to the roadway surface.

   The color pigments shall be selected and blended to provide a marking film which is white or yellow conforming to standard highway colors through the expected life of the film. The yellow color shall conform to Federal Test Standard No. 595B, Color No. 13538 or 13655.

6. Skid Resistance. The surface of the preformed thermoplastic markings shall provide a minimum resistance value of 45 BPN when tested according to ASTM E303.

7. Thickness. The supplied material shall have a minimum thickness of 3.15 mm (0.125 in.).

8. Tensile Strength. The preformed thermoplastic film shall have a minimum tensile strength of 1,030 kPa (150 psi) of cross section, at 3.15 mm (0.125 in.) thickness, when tested according to ASTM D638 except that a sample 150 mm x 25 mm (6 in. x 1 in.) shall be tested at a temperature between 21 °C and 27 °C (70 °F and 80 °F) using a jaw speed of 250 mm to 300 mm (10 in. to 12 in.) per minute.

9. Flexibility. The preformed thermoplastic marking material shall have flexibility at 10 °C (50 °F) such that when a 25 mm x 150 mm (1 in. x 6 in.) sample is bent through an arc of 90° at a uniform rate in 10 seconds (9° per second) over a 25 mm (1 in.) mandrel, no cracking occurs in the test sample. The sample shall be conditioned prior to testing at 10 ± 1 °C (50 ± 2 °F) for a minimum of 4 hours. At least two specimens tested shall meet the flexibility requirements at 10 °C (50 °F) for a passing result.

10. Environmental Resistance. The applied markings shall be resistant to deterioration due to exposure to sunlight, water, oil, diesel fuel, gasoline, pavement oil content, salt, and adverse weather conditions.

11. Effective Performance Life. When properly applied, the pavement markings shall be neat and durable. The markings shall remain reflective and show no fading, lifting, shrinkage, tearing, roll back, or other signs of poor adhesion.

12. Oil/Grease Resistant Testing. The thermoplastic material shall not dissolve or smear after rubbing a small amount of motor oil on a small piece of preformed thermoplastic for 2 minutes.

13. Bond Strength. The material shall exhibit a bond strength to a Portland cement concrete of a minimum of 1.24 MPa (180 psi) when tested at 23 ± 3 °C (73 ± 6 °F) according to ASTM D4796.

14. Packaging. The preformed thermoplastic marking materials, for use as transverse or longitudinal markings as well as legends, arrows, and symbols shall be available in rolls. The material shall be packaged in suitable cartons clearly labeled for ease of identifying the contents. The batch or lot numbers of the material, and month and year the material is packaged shall be stenciled or embossed on the container or included on the label. The preformed thermoplastic material shall be suitable for use for one year after receipt when stored according with the manufacturer's recommendations.

15. Handling. The preformed thermoplastic markings shall not be brittle and shall be sufficiently cohesive and flexible at temperatures exceeding 10 °C (50 °F) for one person to carry without danger of fracturing the material before installation.

16. Durability. The preformed thermoplastic pavement markings shall be capable of conforming to pavement contours, breaks, and faults through the action of traffic at normal pavement temperatures. The markings shall have resealing characteristics such that it is capable of fusing with itself and previously applied thermoplastic when heated with a propane-type torch.

# APPENDIX

## METRIC INFORMATION

## DEFINITIONS

Soft conversion is an exact conversion of the English Unit. Hard conversion is a close approximation of the English unit but is rounded logically in the metric system.

### Basic Dimensions

| | | | |
|---|---|---|---|
| millimeter | (mm) | Newton | (N) |
| meter | (m) | kilonewton | (kN) |
| square meter | ($m^2$) | Joule | (J) |
| cubic meter | ($m^3$) | degree Celsius | (°C) |
| Liter | (L) | gram | (g) |
| Pascal | (Pa) | kilogram | (kg) |
| kilopascal | (kPa) | metric ton | metric ton |
| Megapascal | (MPa) | kilogram per square meter | ($kg/m^2$) |

### Prefixes

| | | |
|---|---|---|
| deci (d) | $10^{-1}$ | one tenth |
| centi (c) | $10^{-2}$ | one hundredth |
| milli (m) | $10^{-3}$ | one thousandth |
| mirco (μ) | $10^{-6}$ | one millionth |
| nano (n) | $10^{-9}$ | one billionth |
| deca (da) | $10^{1}$ | ten |
| hecto (h) | $10^{2}$ | one hundred |
| kilo (k) | $10^{3}$ | one thousand |
| Mega (M) | $10^{6}$ | one million |
| Giga (G) | $10^{9}$ | one billion |

### Metric Measurements

| | | |
|---|---|---|
| Lengths | = | millimeters, meters, kilometers |
| Areas | = | square meters or hectare (10,000 square meters) |
| Volume | = | Liters or cubic meters |
| Mass | = | kilograms, metric tons |
| Force | = | Newton ($N = kg \cdot m/s^2$) |
| Pressure, stress | = | Pascal ($Pa = N/m^2$) |
| Energy, Work | = | Joule ($J = N \cdot m$) |
| Torque | = | Newton meter ($N \cdot m$) |
| Speed, Velocity | = | meters/second, kilometers/hour |
| Acceleration | = | meters/second squared, kilometers/hour squared |
| Density | = | Newton/meter cubed |
| Temperature | = | Celsius (°C) |
| Power | = | Watt (W = J/s) |

## CONVERSIONS

| Conversions | English | To Metric | Multiply Quantity Units By |
|---|---|---|---|
| LENGTHS: | | | |
| | in. | mm | 25.4 |
| | ft | mm | 304.8 |
| | ft | m | 0.3048 |
| | yd | m | 0.9144 |
| | mile | km | 1.609344 |
| | mile | m | 1609.344 |
| | in./mile | mm/km | 15.7828 |
| AREAS: | | | |
| | $in.^2$ | $mm^2$ | 645.16 |
| | $ft^2$ | $m^2$ | 0.092903 |
| | $yd^2$ | $m^2$ | 0.836127 |
| | acre | $m^2$ | 4046.873 |
| | acre | ha | 0.404687 |
| | square mile | $km^2$ | 2.59 |
| VOLUME: | | | |
| | $in.^3$ | $mm^3$ | 16387.06 |
| | $ft^3$ | $m^3$ | 0.0283168 |
| | $yd^3$ | $m^3$ | 0.764555 |
| | gallon | L | 3.78541 |
| | gal/yd | L/m | 4.1398 |
| | $gal/yd^2$ | $L/m^2$ | 4.5273 |
| | $gal/yd^3$ | $L/m^3$ | 4.9511 |
| | gal/acre | L/ha | 9.3539 |
| | gal/ton | L/metric ton | 4.1727 |
| MASSES: | | | |
| | Ounces | g | 28.349523 |
| | Pound | kg | 0.453592 |
| | kip (1,000 lb) | metric ton | 0.453592 |
| | ton | metric ton | 0.907185 |
| FORCES: | | | |
| | Pound | N | 4.44822 |
| | Kip | kN | 4.44822 |
| FORCE/UNIT LENGTH: | | | |
| | lb/ft | N/m | 14.5939 |
| | lb/in. | N/mm | 0.175127 |
| PRESSURE, STRESS: | | | |
| | $lb/ft^2$ | Pa | 47.8803 |
| | $kips/ft^2$ | kPa | 47.8803 |
| | $lb/in.^2$ | kPa | 6.89476 |
| | $lb/in.^2$ | MPa | 0.006895 |
| | $kips/in.^2$ | MPa | 6.89476 |
| ENERGY: | | | |
| | ft•pound | J | 1.35582 |
| MASSES/AREA: | | | |
| | $ounces/yd^2$ | $kg/m^2$ | 0.0339057 |
| | $lb/ft^2$ | $kg/m^2$ | 4.8824 |
| | $lb/yd^2$ | $kg/m^2$ | 0.54249 |
| | lb/acre | kg/ha | 1.1208 |
| | ton/acre | metric ton/ha | 2.2417 |
| MASSES/VOLUME: | | | |
| | $lb/ft^3$ | $kg/m^3$ | 16.01846 |
| | $lb/yd^3$ | $kg/m^3$ | 0.593276 |
| TEMPERATURE: | | | |
| | (°F –32)/1.8 = °C | | |