

**DIVISION C:**  
**TECHNICAL SPECIFICATIONS FOR THE PROJECT**

# **TECHNICAL SPECIFICATIONS**

## **Airport Parking Garage and Surface Lot Improvements (PRCS) Project No. 33-00196**

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## TECHNICAL SPECIFICATIONS

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## DEFINITION OF TERMS

**Applicability.** Wherever the following terms are used in these specifications or other Contract documents, the intent and meaning will be interpreted as shown below.

### Abbreviations:

AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute
ACPA	American Concrete Pipe Association
AI	Asphalt Institute
AISC	American Institute of Steel Construction
AMRL	AASHTO Materials Reference Laboratory
ANSI	American National Standards Institute
APWA	American Public Works Association
AREMA	American Railway Engineering and Maintenance-of-Way Association
ASCE	American Society of Civil Engineers
ASLA	American Society of Landscape Architects
ASME	American Society of Mechanical Engineers
ASNT	American Society for Nondestructive Testing
ASTM	American Society for Testing and Materials
AWS	American Welding Society
AWWA	American Water Works Association
BMP	Best Management Practices
CFR	Code of Federal Regulations
CIMS	Capital Improvements Management Services Department of the City of San Antonio
CMP	Corrugated Metal Pipe
COE	U.S. Army Corps of Engineers
COSA	City of San Antonio
CRSI	Concrete Reinforcing Steel Institute
DMS	Departmental Material Specification
EPA	United States Environmental Protection Agency
FHWA	Federal Highway Administration, U.S. Department of Transportation
GSA	General Services Administration
IEEE	Institute of Electrical and Electronics Engineers
ISO	International Organization for Standardization
ITE	Institute of Transportation Engineers
LRFD	Load Resistance Factor Design
NCHRP	National Cooperative Highway Research Program
NEC	National Electrical Code (Published by NFPA)
NEMA	National Electrical Manufacturers Association
NEPA	National Environmental Policy Act
NESC	National Electrical Safety Code
NIST	National Institute of Standards and Technology
NRMCA	National Ready Mixed Concrete Association
OSHA	Occupational Safety & Health Administration, U.S. Department of Labor
PCA	Portland Cement Association
PCI	Precast/Prestressed Concrete Institute
PSI	Pounds Per Square Inch
PPI	Plastics Pipe Institute

PS&E	Plans, Specifications, and Estimate
PW	Public Works Department of the City of San Antonio
RCP	Reinforced Concrete Pipe
RPLS	Registered Public Land Surveyor
RRC	Railroad Commission of Texas
SAE	Society of Automotive Engineers
SI	International System of Units
SSPC	The Society for Protective Coatings
TAC	Texas Administrative Code
TCEQ	Texas Commission on Environmental Quality
TDLR	Texas Department of Licensing and Regulation
TMUTCD	Texas Manual on Uniform Traffic Control Devices for Streets and Highways
UL	Underwriters Laboratory, Inc.
USC	United States Code
WRI	Wire Reinforcement Institute

### Definitions:

1. **Actual Cost.** Contractor's actual cost to provide labor, material, equipment, and project overhead necessary for the work.
2. **Air Temperature.** The temperature measured in degrees Fahrenheit (°F) in the shade, not in the direct rays of the sun, and away from artificial heat.
3. **Arterial Highway.** A highway used primarily for through traffic and usually on a continuous route.
4. **Award.** The City's acceptance of a Contractor's bid for a proposed Contract that authorizes the City to enter into a Contract.
5. **Bidder.** An individual, partnership, limited liability company, corporation, or joint venture submitting a bid for a proposed Contract.
6. **Bridge.** A structure, including supports, erected over a depression or an obstruction (e.g., water, a highway, or a railway) having a roadway or track for carrying traffic or other moving loads, and having an opening measured along the center of the roadway of more than 20 ft. between faces of abutments, spring lines of arches, or extreme ends of the openings for multiple box culverts.
7. **Callout Work.** Contracts, or work items in Contracts, that require a Contractor's response on an as-needed basis.
8. **Certificate of Insurance.** A form approved by the City covering insurance requirements stated in the Contract.
9. **Change Order.** Written order to the Contractor detailing changes to the specified work, item quantities or any other modification to the Contract.
10. **City or City of San Antonio.** The governmental entities that comprise the City of San Antonio.
11. **Construction Bulletin C-8.** TxDOT Manual of procedures for driving and test loading piling.
12. **Construction Bulletin C-9.** TxDOT Manual of procedures for constructing and test loading drilled shafts.
13. **Consultant.** The licensed professional engineer or engineering firm, or the architect or architectural firm, registered in the State of Texas and under Contract to the City to perform professional services. The consultant may be the Engineer or architect of record or may provide services through and be subcontracted to the Engineer or architect of record.
14. **Contract.** The agreement between the City of San Antonio and the Contractor establishing the obligations of the parties for furnishing of materials and performance of the work prescribed in the Contract documents.
15. **Contract Documents.** Elements of the Contract including but not limited to the plans, specifications incorporated by reference, special provisions, special specifications, Contract bonds, change orders, and supplemental agreements.

16. **Contract Time.** The number of working days specified for completion of the work including authorized additional working days.
17. **Contractor.** The individual, partnership, limited liability company, corporation, or joint venture and all principals and representatives with which the Contract is made by the City.
18. **Control of Access.** The condition in which the right to access of owners or occupants of abutting land or other persons in connection with a street, roadway, or highway is fully or partially controlled by public authority.
19. **Cross-Sections.** Graphic representations of the original ground and the proposed facility, at right angles to the centerline or base line.
20. **Culvert.** Any buried structure providing an opening under a roadway for drainage or other purposes. Culverts may also be classified as bridges.
21. **Date of Written Authorization.** Date of the written work order authorizing the Contractor to begin work.
22. **Detour.** A temporary traffic route around a closed portion of a road.
23. **Department.** The Texas Department of Transportation (TxDOT).
24. **Departmental Material Specifications (DMS).** Reference specifications for various materials published by the TxDOT Construction Division.
25. **Direct Traffic Culvert.** Concrete box culvert whose top slab is used as the final riding surface or is to have an overlay or other riding surface treatment.
26. **Engineer.** The Capital Improvements Management Services (CIMS) Director of the City of San Antonio or the authorized representative of the CIMS Director. May also be the Public Works Director of the City of San Antonio or the authorized representative of the PW Director.
27. **Hazardous Materials or Waste.** Hazardous materials or waste include but are not limited to explosives, compressed gas, flammable liquids, flammable solids, combustible liquids, oxidizers, poisons, radioactive materials, corrosives, etiologic agents, and other material classified as hazardous by 40 CFR 261, or applicable state and federal regulations.
28. **Highway, Street, or Road.** General terms denoting a public way for purposes of vehicular travel, including the entire area within the right of way. Recommended usage in urban areas is highway or street; in rural areas, highway or road.
29. **Inspector.** The person assigned by the Engineer to inspect for compliance with the Contract any or all parts of the work and the materials used.
30. **Intersection.** The general area where 2 or more highways, streets, or roads join or cross, including the roadway and roadside facilities for traffic movements within it.
31. **Island.** An area within a roadway from which vehicular traffic is intended to be excluded, together with any area at the approach occupied by protective deflecting or warning devices.
32. **Licensed Professional Engineer.** A person who has been duly licensed by the Texas Board of Professional Engineers to engage in the practice of engineering in the State of Texas; also referred to as a Professional Engineer.
33. **Limits of Construction.** An area with established boundaries, identified within the highway right of way and easements, where the Contractor is permitted to perform the work.
34. **Local Street or Road.** A street or road primarily for access to residence, business, or other abutting property.
35. **Manual of Testing Procedures.** TxDOT Department manual outlining test methods and procedures maintained by the Materials and Pavements Section of the Construction Division.
36. **Median.** The portion of a divided highway separating the traffic lanes in opposite directions.
37. **Milestone Date.** The date that a specific portion of the work is to be completed, before the completion date for all work under the Contract.
38. **National Holiday.** January 1, the last Monday in May, July 4, the first Monday in September, the fourth Thursday in November, December 24, or December 25.

39. **Nonhazardous Recyclable Material (NRM).** A material recovered or diverted from the nonhazardous waste stream for the purposes of reuse or recycling in the manufacture of products that may otherwise be produced using raw or virgin materials.
40. **Notification.** Either written or oral instruction to the Contractor concerning the work. Voice mail is oral notification.
41. **Pavement.** That part of the roadway having a constructed surface for the use of vehicular traffic.
42. **Pavement Structure.** Combination of surface course and base course placed on a subgrade to support the traffic load and distribute it to the roadbed.
  - A. **Surface Course.** Pavement structure layers designed to accommodate the traffic load. The top layer resists skidding, traffic abrasion, and the disintegrating effects of climate and is sometimes called the wearing course.
  - B. **Base Course.** One or more layers of specified material thickness placed on a subgrade to support a surface course.
  - C. **Subgrade.** The top surface of a roadbed upon which the pavement structure, shoulders, and curbs are constructed.
  - D. **Subgrade Treatment.** Modifying or stabilizing material in the subgrade.
43. **Plans.** The drawings approved by the Engineer including true reproductions of the drawings that show the location, character, dimensions, and details of the work and are a part of the Contract.
44. **Prequalification.** The process for determining a Contractor's eligibility to bid work.
45. **Proposal.** The offer of the Bidder submitted on the prescribed form, including addenda issued, giving unit bid prices for performing the work described in the plans and specifications.
46. **Quality Assurance (QA).** Sampling, testing, inspection, and other activities conducted by the Engineer to determine payment and make acceptance decisions.
47. **Quality Control (QC).** Sampling, testing, and other process control activities conducted by the Contractor to monitor production and placement operations.
48. **Referee Tests.** Tests requested to resolve differences between Contractor and Engineer test results. The referee laboratory will be designated by the City of San Antonio.
49. **Right of Way.** A general term denoting land or property devoted to transportation purposes.
50. **Roadbed.** The graded portion of a highway prepared as foundation for the pavement structure and shoulders. On divided highways, the depressed median type and the raised median type highways are considered to have 2 roadbeds. Highways with a flush median are considered to have 1 roadbed.
51. **Roadside.** The areas between the outside edges of the shoulders and the right of way boundaries. Unpaved median areas between inside shoulders of divided highways and areas within interchanges are included.
52. **Roadway.** The portion of the highway (including shoulders) used by the traveling public.
53. **Sidewalk.** Portion of the right of way constructed exclusively for pedestrian use.
54. **Special Provisions.** Additions or revisions to these standard specifications or special specifications.
55. **Special Specifications.** Supplemental specifications applicable to the Contract not covered by these standard specifications.
56. **Specifications.** Directives or requirements issued or made pertaining to the method and manner of performing the work or to quantities and qualities of materials to be furnished under the Contract. References to TxDOT DMSs, ASTM or AASHTO specifications, or TxDOT bulletins and manuals, imply the latest standard or tentative standard in effect on the date of the proposal. The Engineer will consider incorporation of subsequent changes to these documents in the project Scope of Work.
57. **State.** The State of Texas.
58. **Station.** A unit of measurement consisting of 100 horizontal feet.
59. **Subcontract.** The agreement between the Contractor and subcontractor establishing the obligations of the parties for furnishing of materials and performance of the work prescribed in the Contract documents.
60. **Subcontractor.** An individual, partnership, limited liability company, corporation, or any combination thereof that the Contractor sublets, or proposes to sublet, any portion of a Contract,

excluding a material supplier, truck owner-operator, wholly owned subsidiary, or specialty-type businesses such as security companies and rental companies.

61. **Subsidiary.** Materials, labor, or other elements that because of their nature or quantity have not been identified as a separate item and are included within the items on which they necessarily depend.
62. **Substructure.** The part of the structure below the bridge seats or below the springing lines of arches. Parapets, back walls, and wing walls of abutments are considered as parts of the substructure.
63. **Superintendent.** The representative of the Contractor who is available at all times and able to receive instructions from the Engineer or authorized City representatives and to act for the Contractor.
64. **Superstructure.** The part of the structure above the bridge seats or above the springing lines of arches.
65. **Surplus Materials.** Any debris or material related to the Contract not incorporated into the work.
66. **Traffic Lane.** The strip of roadway intended to accommodate the forward movement of a single line of vehicles.
67. **Utility.** Privately, publicly, or cooperatively owned lines, facilities, and systems for producing, transmitting, or distributing communications, power, heat, gas, oil, water, waste, or storm water that are not connected with the highway drainage, signal systems, or other products that directly or indirectly serve the public; the utility company.
68. **Verification Tests.** Tests used to verify accuracy of QC and QA and mixture design testing.
69. **Wholly Owned Subsidiary.** A legal entity owned entirely by the Contractor or subcontractor.
70. **Work.** The furnishing of all labor, materials, equipment, and other incidentals necessary for the successful completion of the Contract.
71. **Work Order.** Written notice to the Contractor to begin the work. The work order may include the date on which work or time charges are to begin, the number of working days for specified work (for multiple work order Contracts), and plan sheets providing additional details specific to a location or to an item of work for non-site-specific work.
72. **Written Notice.** Written notice is considered to have been duly given if delivered in person to the individual or member to whom it is intended or if sent by regular, registered, or certified mail and delivered to the last known business address; sent by facsimile to the last known phone number; or sent by e-mail to the last known address. The date of the letter will serve as the beginning day of notice. Unclaimed mail or failure to provide current mailing address will not be considered a failure to provide written notice.

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## DIVISION I - EARTHWORK

### ITEM

#### 100 MOBILIZATION

**100.1. DESCRIPTION:** *Establish and remove offices, plants, and facilities. Move personnel, equipment, and supplies to and from the project or the vicinity of the project site to begin work or complete work on Contract Items.*

**100.2. MEASUREMENT:** This Item will be measured by the lump sum as the work progresses.

**100.3. PAYMENT:** Partial payments of the lump sum bid for mobilization will be as follows. The adjusted Contract amount for construction Items as used below is defined as the total Contract amount less the lump sum for mobilization.

- A. Payment will be made upon presentation of a paid invoice for the payment bond, performance bond, and required insurance. The combined payment for bonds and insurance will be no more than 10% of the mobilization lump sum or 1% of the total Contract amount, whichever is less.
- B. Payment will be made upon verification of documented expenditures for plant and facility setup. The combined amount for all these facilities will be no more than 10% of the mobilization lump sum or 1% of the total Contract amount, whichever is less.
- C. When 1% of the adjusted Contract amount for construction Items is earned, 50% of the mobilization lump sum bid or 5% of the total Contract amount, whichever is less, will be paid. Previous payments under this Item will be deducted from this amount.
- D. When 5% of the adjusted Contract amount for construction Items is earned, 75% of the mobilization lump sum bid or 10% of the total Contract amount, whichever is less, will be paid. Previous payments under the Item will be deducted from this amount.
- E. When 10% of the adjusted Contract amount for construction Items is earned, 90% of the mobilization lump sum bid or 10% of the total Contract amount, whichever is less, will be paid. Previous payments under this Item will be deducted from this amount.
- F. Payment for the remainder of the lump sum bid for "Mobilization" will be made on the next estimate cycle after the initial retainage estimate or at final acceptance for projects without retainage.

**100.4. BID ITEM:**

Item 100.1 - Mobilization - lump sum

Item 100.2 - Insurance and Bond - lump sum

## ITEM

### 103 REMOVE CONCRETE

**103.1. DESCRIPTION:** *This item shall govern the breaking up, removing, and satisfactorily disposing of existing concrete, as classified, at locations shown on the plans or as directed by the Engineer. Existing concrete not shown on the plans, located beneath the natural ground surface, not indicated by the Engineer or not obvious to the naked eye will not be covered under this item. Such materials will be removed as needed and paid for under Item 104 "Street Excavation," Item 105 "Channel Excavation," or Item 306 "Structural Excavation."*

**103.2. CLASSIFICATION:** Existing concrete to be removed under this item will be classified as follows:

- A. Concrete Curb.** "Concrete Curb" will include curb, curb and gutter, and low curb at driveways, and combinations thereof. The removal of monolithic concrete curb or doweled concrete curb will be included in the concrete pavement measurement.
- B. Concrete Traffic Barrier.** "Concrete Traffic Barrier" will include permanent concrete barrier used for channeling or dividing traffic that is not considered salvageable.
- C. Sidewalks and Driveways.** "Sidewalks and Driveways" will include concrete sidewalks and driveways.
- D. Miscellaneous Concrete.** "Miscellaneous Concrete" will include all other items that are not noted above or covered by other items.

**103.3. EQUIPMENT:** Provide the machinery, tools and equipment necessary for proper prosecution of the work. All machinery, tools and equipment used shall be maintained in a satisfactory and workmanlike manner.

**103.4. CONSTRUCTION:**

- A. General.** The existing concrete shall be broken up, removed, and disposed of by the Contractor in accordance with federal, state, and local regulations.
- B. Partial Removal of Concrete.** When only a portion of the existing concrete is to be removed, care shall be exercised to avoid damage to that portion to remain in place. The existing concrete shall be cut to neat lines shown on the plans or as established by the Engineer, by sawing with an appropriate type circular concrete saw to a minimum depth of ½-inch. Any existing concrete which is damaged or destroyed beyond the neat lines so established shall be replaced at the Contractor's expense. Where reinforcement is encountered in the removed portions of the concrete, a minimum of 1-foot shall be cleaned of all old concrete and left in place to tie into the new concrete construction.

**103.5. MEASUREMENT:** Measurement for this item will be conducted as follows:

- A. Concrete Curb.** Concrete curb removed as prescribed above will be measured by the linear foot in its original position regardless of the thickness and reinforcing steel encountered.
- B. Concrete Traffic Barrier.** Concrete Traffic Barrier as prescribed above will be measured by the linear foot in its original position regardless of the type or size encountered.

**C. Concrete Sidewalk and Driveway.** Concrete sidewalks and driveways removed as prescribed above will be measured by the square foot in its original position regardless of the thickness of the concrete and reinforcing steel encountered.

**D. Miscellaneous Concrete.** Miscellaneous Concrete will be measured by the square foot in its original position regardless of the thickness of the concrete and reinforcing steel encountered.

**103.6. PAYMENT:** This item will be paid for at the contract unit price bid for “Remove Concrete Curb,” “Remove Concrete Traffic Barrier,” “Remove Concrete Sidewalks and Driveways,” or “Remove Miscellaneous Concrete” which price shall be full compensation for all work herein specified, including the furnishing of all materials, equipment, tools, labor and incidentals necessary to complete the work.

**103.7. BID ITEM:**

Item 103.1 - N/A

Item 103.2 - N/A

Item 103.3 - Remove Miscellaneous Concrete - per square foot

Item 103.4 - Remove Miscellaneous Asphalt Pavement - per square foot

## ITEM

### 108 LIME TREATED SUBGRADE

**108.1. DESCRIPTION:** *Treat the subgrade by pulverizing, adding lime, mixing, and compacting to the required density. This item applies to both natural ground and embankment subgrade and shall be constructed as specified herein and in conformance with the typical sections, lines and grades as shown on the plans or as established by the Engineer.*

**108.2. MATERIALS:** Lime for this item shall conform to the requirements of TxDOT Item No. 260, "Lime Treatment – Road Mixed" of the Texas Department of Transportation Standard Specifications (Latest Edition). Acceptable forms of lime shall be:

- "Type A, Hydrated Lime,"
- "Type B, Commercial Lime Slurry," or
- "Type C, Quicklime."

The Contractor shall select, prior to construction, the grade to be used and shall notify the Engineer in writing before changing from one grade to another. Lime shall be placed in slurry form only, unless written permission is granted by the Engineer and a safety and containment plan is submitted to the Engineer by the Contractor seven days prior to use. In circumstances where it would be beneficial to utilize lime for "drying" subgrade materials to expedite construction, the Contractor may request approval from the Engineer to use pelletized lime.

Provide materials in conformance with the following Items and requirements:

**A. Lime.** TxDOT DMS-6350 "Lime and Lime Slurry."

**B. Mix Design.** The Engineer will determine the target lime content and optimum moisture content in accordance with TxDOT Tex -121-E.

**108.3. EQUIPMENT:** The machinery, tools and equipment necessary for proper prosecution of the work shall be on the project and approved by the Engineer prior to the beginning of construction operations. All machinery, tools and equipment used shall be maintained in a satisfactory and workmanlike manner.

When lime is furnished in trucks, the weight of lime shall be determined on certified scales and delivered to the job site with exit ports sealed at the plant.

**108.4. CONSTRUCTION:**

**A. General.** The completed course shall be uniformly treated, free from loose or segregated areas, of uniform density and moisture content, well bound for its full depth and shall have a smooth surface.

**B. Preparation of Subgrade or Existing Base.** Prior to treating existing material, it shall be shaped to conform to the typical sections, as shown on the plans.

Before pulverizing or scarifying an existing material, when directed by the Engineer, the Contractor shall proof roll the roadbed in accordance with TxDOT Item 216, "Proof Rolling."

Soft spots shall be corrected as directed by the Engineer. When the Contractor elects to use a cutting and pulverizing machine that will process the material to the plan depth, the Contractor will not be required to excavate to the secondary grade or windrow the material. This method will be permitted only if a machine is provided which will insure that the material is cut uniformly to the proper depth and which has cutters that will plane the secondary grade to a uniform surface over the entire width of the cut. The machine shall provide a visible indication of the depth of cut at all times.

In lieu of using the cutting and pulverizing machine, the Contractor shall excavate and windrow the material to expose the secondary grade to the typical sections, lines and grades as shown on the plans or as established by the Engineer.

- C. Pulverization.** The existing pavement or base material shall be pulverized or scarified so that 100 % shall pass the 2-½ inch sieve.
- D. Application.** The percentage by weight or pounds per square yard of lime to be added will be as shown on the plans and may be varied by the Engineer if conditions warrant.

Lime shall be spread only on that area where the mixing operations can be completed during the same working day.

Unless otherwise approved by the Engineer, the lime operation shall not be started when the air temperature is below 40°F and falling, but may be started when the air temperature is above 35°F and rising. The temperature will be taken in the shade and away from artificial heat. Lime shall not be placed when weather conditions in the opinion of the Engineer are unsuitable.

The application and mixing of lime with the material shall be accomplished by the methods herein described as "Slurry Placing." "Dry Placing" is not allowed unless approved by the Engineer as described in Section 108.2, "Materials." Type A, Hydrated Lime shall be applied by "Slurry Placing" unless otherwise shown on the plans or approved by the Engineer. Type B Commercial Lime Slurry shall be applied by "Slurry Placing." Type C Quicklime shall be applied by "Slurry Placing" only. "Dry Placing" will not be allowed unless approved by the Engineer. When Type C Quicklime is used for dry placement, it shall be Grade "DS." When Type C Quicklime is used for slurry placement, it shall be either Grade "DS" or Grade "S." Grade "S" shall be used in slurry placement only.

**CAUTION:** Use of quicklime can be dangerous. Users should be informed of the recommended precautions in handling, storage and use of quicklime.

- 1. Slurry Placing.** When Type A Hydrated Lime is specified and slurry placement is to be used, the Type A Hydrated Lime shall be mixed with water to form a slurry with a solids content approved by the Engineer.

Type B Commercial Lime Slurry shall be delivered to the project in slurry form at or above the minimum dry solids content approved by the Engineer. The distribution of lime at the rate(s) shown on the plans or approved by the Engineer shall be attained by successive passes over a measured section of roadway until the proper lime content has been secured.

When Type C Quicklime is applied as slurry, the amount of dry quicklime shall be 80 percent of the amount shown on the plans. The slurry shall contain at least the minimum

dry solids content approved by the Engineer. The residue from the slurring procedure shall be spread uniformly over the length of the roadway currently being processed unless otherwise approved by the Engineer. This residue is primarily inert material with little stabilizing value, but may contain a small amount of quicklime particles that slake slowly. A concentration of these particles could cause the compacted stabilized material to swell during slaking.

Slurry shall be of such consistency that it can be applied uniformly without difficulty.

When the distributor truck is not equipped with an agitator, the Contractor shall have a standby pump available on the project for agitating the lime and water as required by the Engineer in case of undue delays in dispersing the slurry.

2. **Dry Placing.** Dry placing is not allowed unless approved by the Engineer as described in Section 108.2, "Materials." If allowed, the lime shall be distributed by an approved spreader at the rate shown on the plans or as directed by the Engineer. The lime shall be distributed at a uniform rate and in such a manner as to reduce the scattering of lime by the wind. The material shall be sprinkled as approved by the Inspector.
- E. Mixing.** The mixing procedure shall be the same for "Slurry Placing" or "Dry Placing" as herein described.

Begin Mixing within 6 hours of lime application. During the interval between application and mixing, hydrated lime that has been exposed to the open air for a period of six (6) hours or more or to excessive loss due to washing or blowing will not be accepted for payment.

1. **Initial Mixing.** The material and lime shall be thoroughly mixed. The material and lime shall be brought to the proper moisture content and left to mellow for 1 to 4 days. When pebble grade quicklime is used, allow the mixture to mellow for 2 to 4 days as approved by the Engineer.

In addition to the above, when Type C Quicklime, Grade "DS," is approved for use by the Engineer under "Dry Placing," the material and lime shall be mixed as thoroughly as possible at the time of the lime application. Sufficient moisture shall be added during the mixing to hydrate the quicklime.

During the mellowing period, the material shall be kept moist as directed by the Inspector.

When shown on the plans or approved by the Engineer, the pulverization requirement may be waived when the material contains a substantial quantity of aggregate.

2. **Final Mixing.** After the required mellowing time, the material shall be uniformly mixed by approved methods. If the soil binder-lime mixture contains clods, they shall be reduced in size by the use of approved pulverization methods.

Following mixing, a sample of the material at roadway moisture will be obtained for pulverization testing. All non-slaking aggregates retained on the  $\frac{3}{4}$  inch sieve will be removed from the sample. The remainder of the material shall meet the following pulverization requirement when tested by TXDOT Test Method Tex-101-E, Part III:

Minimum passing 1 3/4" sieve	100
Minimum passing 3/4" sieve	85
Minimum passing No. 4 sieve	60

- F. Compaction.** Prior to compaction, the material shall be aerated or sprinkled as necessary to provide the optimum moisture. Compaction of the mixture shall begin immediately after final mixing and in no case more than 24 hours after final mixing.

Compaction shall continue until the entire depth of the mixture is uniformly compacted. Throughout this entire operation, the shape of the course shall be maintained by blading, and the surface upon completion shall be smooth and in conformity with the typical sections, lines and grades as shown on the plans or as established by the Engineer.

- 1. Ordinary Compaction.** Roll with approved compaction equipment, as directed. Correct irregularities, depressions, and weak spots immediately by scarifying the areas affected, adding or removing treated material as required, reshaping, and recompacting.
- 2. Density Control.** Each course shall be sprinkled as required and compacted to the extent necessary to provide not less than 95 percent of the optimum density. Unless otherwise shown on the plans, the Engineer will determine roadway density of completed sections in accordance with TxDOT Test Method Tex-115-E. The Engineer may accept the section if no more than 1 of the 5 most recent density tests is below the specified density and the failing test is no more than 3 pcf below the specified density.

When the material fails to meet the density requirements, or should the material lose the required stability, density or finish before the next course is placed, or the project is accepted, it shall be reworked as specified below.

- G. Reworking a Section.** When a section is reworked within 72 hours after completion of compaction, the Contractor shall rework the section to provide the required compaction. When a section is reworked more than 72 hours after completion of compaction, the Contractor shall add 25 percent of the specified rate of lime. Reworking shall include loosening, road mixing as approved by the Engineer, compacting, and finishing. When a section is reworked, a new optimum density will be determined from the reworked material in accordance with TXDOT Test Method Tex-121-E, part II and shall compact in-place to a minimum of 95% of this density.

- H. Finishing.** Immediately after completing compaction, clip, skin, or tight-blade the surface of the lime treated material with a maintainer or subgrade trimmer to a depth of approximately 1/4-inch. Remove loosened material and dispose of it at an approved location. Roll the clipped surface immediately with a pneumatic-tire roller until a smooth surface is attained. Add small increments of water as needed during rolling. Shape and maintain the course and surface in conformity with the typical sections, lines and grades shown on the plans or as directed.

Finish grade of constructed subgrade in accordance with the following grade tolerances

- 1. Staged Construction.** Grade to within 0.1-foot in the cross-section and 0.1-foot in 16-foot measured longitudinally.

2. **Turnkey Construction.** Grade to within ½-inch in the cross-section and ½-inch in 16-foot measured longitudinally.

Do not surface patch.

- I. **Curing.** After the final layer or course of the lime treated material has been compacted, it shall be brought to the required lines and grades in accordance with the typical sections.

The completed section shall then be finished by rolling with a pneumatic tire or other suitable roller. The completed section shall be moist cured or prevented from drying by addition of an asphalt material at the rate of 0.05 to 0.20 gallons per square yard. Curing shall continue for 2 to 5 days before further courses are added or traffic is permitted, unless otherwise approved by the Engineer.

However, the lime treated material may be covered by other courses, the day following finishing, when approved by the Engineer. When the plans provide for the treated material to be covered by other courses of material, the next course shall be applied within 14 calendar days after final compaction is completed, unless otherwise approved by the Engineer.

- 108.5. **MEASUREMENT:** When Lime is furnished in trucks, the weight of lime will be determined on certified scales, or the Contractor must provide a set of standard platform scales at a location approved by the Engineer. Scales must conform to the requirements of TxDOT Standard Specification Item 520, "Weighing and Measuring Equipment."

**A. Hydrated Lime.**

1. **Dry.** Lime will be measured by the ton (Dry Weight).
2. **Slurry.** Lime slurry will be measured by the ton (dry weight) of the hydrated lime used to prepare the slurry at the site.
3. **Commercial Lime Slurry.** Lime slurry will be measured by the ton (dry weight) as calculated from the minimum percent dry solids content of the slurry, multiplied by the weight of the slurry in tons delivered.

**B. Quicklime.**

1. **Dry.** Lime will be measured by the ton (dry weight) of the quicklime.
2. **Slurry.** Lime slurry will be measured by the ton (dry weight) of the quicklime used to prepare the slurry multiplied by a conversion factor of 1.28 to give the quantity of equivalent hydrated lime, which will be the basis of the payment

- 108.6. **PAYMENT:** Work performed and materials furnished as prescribed by this item and measured as provided under "Measurement" will be paid for as follows:

"Lime" will be paid for at the unit price bid per ton of 2,000 pounds for "Lime" of the type specified, not to exceed 1% of the calculated quantity (based on delivered weight), which price shall be full compensation for furnishing all lime.

"Lime Treatment for Subgrade" will be paid for at the contract unit price bid per square yard, which price shall be full compensation for all correction of secondary subgrade, for loosening, mixing, pulverizing, spreading, drying, application of lime, water content of the slurry, shaping

and maintaining, for all sprinkling and rolling, for all manipulations required, for all hauling and freight involved, for all tools, equipment, labor and incidentals necessary to complete the work.

**108.7. BID ITEM:**

Item 108.1 - Lime Treated Subgrade - ( 6 inches compacted depth) - per square yard

## DIVISION II - BASE & SURFACE COURSES

### ITEM

#### 200 FLEXIBLE BASE

- 200.1. DESCRIPTION:** *Construct a base course for surfacing, pavement, or other base courses composed of crushed stone, and constructed as herein specified in one or more courses in conformance with the typical sections shown on the plans and to the lines and grades as established by the Engineer.*
- 200.2. MATERIALS:** Furnish uncontaminated materials of uniform quality that meet the requirements of the plans and specifications. Notify the Engineer of the proposed material sources and of changes to material sources. The Engineer may sample and test project materials at any time before compaction throughout the duration of the project to assure specification compliance. Use the TxDOT standard laboratory test procedure Tex-100-E for material definitions.
- A. Aggregate.** Furnish aggregate of the type and grade shown on the plans and conforming to the requirements of Table 1. Each source must meet Table 1 requirements for liquid limit, plasticity index, and wet ball mill for the grade specified. Do not use additives such as but not limited to lime, cement, or fly ash to modify aggregates to meet the requirements of Table 1, unless shown on the plans.

**Table 1**  
**Aggregate Material Requirements**

Property	Test Method <sup>1</sup>	Grade 1	Grade 2	Grade 3	Grade 4
Master gradation sieve size (% retained)	Tex-110-E				As shown on the plans
2-½ in.		–	0	0	
1-¾ in.		0	0–10	0–10	
¾ in.		10–35	–	–	
¾ in.		30–50	–	–	
No. 4		45–65	45–75	45–75	
No. 40		70–85	60–85	50–85	
Liquid limit, % max. <sup>2</sup>	Tex-104-E	35	40	40	As shown on the plans
Plasticity index, max. <sup>2</sup>	Tex-106-E	10	12	12	As shown on the plans
Plasticity index, min. <sup>2</sup>		As shown on the plans			
Wet ball mill, % max. <sup>3</sup>	Tex-116-E	40	45	–	As shown on the plans
Wet ball mill, % max. increase passing the No. 40 sieve <sup>3</sup>		20	20	–	

1. TxDOT standard laboratory test procedures

2. Determine plastic index in accordance with Tex-107-E (linear shrinkage) when liquid limit is unattainable as defined in Tex-104-E.

3. ASTM C131 (Grad. A), Los Angeles Abrasion, can be used in lieu of the wet ball mill procedure. The maximum abrasion allowed to the crushed stone is forty (40) when subjected to the Los Angeles Abrasion test.

- 1. Material Tolerances.** The Engineer may accept material if no more than 1 of the 5 most recent gradation tests has an individual sieve outside the specified limits of the gradation.

When target grading is required by the plans, no single failing test may exceed the master grading by more than 5 percentage points on sieves No. 4 and larger or 3 percentage points on sieves smaller than No. 4 sieve.

The Engineer may accept material if no more than 1 of the 5 most recent plasticity index tests is outside the specified limit. No single failing test may exceed the allowable limit by more than 2 points.

2. **Material Types.** Do not use fillers or binders unless approved by the Engineer. Furnish the type specified on the plans in accordance with the following.
  - a. **Type A.** Crushed stone produced and graded from oversize quarried aggregate that originates from a single, naturally occurring source. Do not use gravel or multiple sources.
  - b. **Type B.** Crushed or uncrushed gravel. Blending of 2 or more sources is allowed. Use of this material must have written approval by the City Engineer prior to selection for bidding or construction.
  - c. **Type C.** Crushed gravel with a minimum of 60% of the particles retained on a No. 4 sieve with 2 or more crushed faces as determined by TxDOT's standard laboratory test procedure Tex-460-A, Part I. Blending of 2 or more sources is allowed.
  - d. **Type D.** Type A material or crushed concrete. Crushed concrete containing gravel will be considered Type D material. Crushed concrete must meet the requirements in Section 200.2.A.3.b, "Recycled Material (Including Crushed Concrete) Requirements," and be managed in a way to provide for uniform quality. The Engineer may require separate dedicated stockpiles in order to verify compliance.
  - e. **Type E.** As shown on the plans.
3. **Recycled Material.** Recycled asphalt pavement (RAP) and other recycled materials may be used when shown on the plans. Request approval to blend 2 or more sources of recycled materials.
  - a. **Limits on Percentage.** When RAP is allowed, do not exceed 20% RAP by weight unless otherwise shown on the plans. The percentage limitations for other recycled materials will be as shown on the plans.
  - b. **Recycled Material (Including Crushed Concrete) Requirements.**
    - (1) **Contractor Furnished Recycled Materials.** When the Contractor furnishes the recycled materials, including crushed concrete, the final product will be subject to the requirements of Table 1 for the grade specified. Certify compliance with TxDOT's DMS-11000, "Evaluating and Using Nonhazardous Recyclable Materials Guidelines," for Contractor furnished recycled materials. In addition, recycled materials must be free from reinforcing steel and other objectionable material and have at most 1.5% deleterious material when tested in accordance with TxDOT's standard laboratory test procedure Tex-413-A. For RAP, do not exceed a maximum percent loss from decantation of 5.0% when tested in accordance with TxDOT's standard laboratory test procedure Tex-406-A. Test RAP without removing the asphalt.

**(2) City Furnished Required Recycled Materials.** When the City furnishes and requires the use of recycled materials, unless otherwise shown on the plans:

- City required recycled material will not be subject to the requirements in Table 1,
- Contractor furnished materials are subject to the requirements in Table 1 and this Item,
- the final product, blended, will be subject to the requirements in Table 1, and
- for final product, unblended (100% City furnished required recycled material), the liquid limit, plasticity index, wet ball mill, classification, and compressive strength is waived.

Crush City-furnished RAP so that 100% passes the 2 inch sieve. The Contractor is responsible for uniformly blending to meet the percentage required.

**(3) City Furnished and Allowed Recycled Materials.** When the City furnishes and allows the use of recycled materials or allows the Contractor to furnish recycled materials, the final blended product is subject to the requirements of Table 1 and the plans.

- c. Recycled Material Sources.** City-owned recycled material is available to the Contractor only when shown on the plans. Return unused City-owned recycled materials to the City stockpile location designated by the Engineer unless otherwise shown on the plans.

The use of Contractor-owned recycled materials is allowed when shown on the plans. Contractor-owned surplus recycled materials remain the property of the Contractor. Remove Contractor-owned recycled materials from the project and dispose of them in accordance with federal, state, and local regulations before project acceptance. Do not intermingle Contractor-owned recycled material with City-owned recycled material unless approved by the Engineer.

**B. Water.** Furnish water free of industrial wastes and other objectionable matter.

**C. Material Sources.** Only commercial sources may be used unless otherwise allowed by the City and shown on the plans.

**200.3. EQUIPMENT:** Provide machinery, tools, and equipment necessary for proper execution of the work. Provide rollers in accordance with Item 210, "Rolling." Provide proof rollers in accordance with TxDOT Item 216, "Proof Rolling," when required.

**200.4. CONSTRUCTION:** Construct each layer uniformly, free of loose or segregated areas, and with the required density and moisture content. Provide a smooth surface that conforms to the typical sections, lines, and grades shown on the plans or as directed.

Stockpile base material temporarily at an approved location before delivery to the roadway. Build stockpiles in layers no greater than 2 feet thick. Stockpiles must have a total height between 10 and 16 feet unless otherwise shown on the plans. After construction and acceptance of the

stockpile, loading from the stockpile for delivery is allowed. Load by making successive vertical cuts through the entire depth of the stockpile.

Do not add or remove material from temporary stockpiles that require sampling and testing before delivery unless otherwise approved. Charges for additional sampling and testing required as a result of adding or removing material will be deducted from the Contractor's estimates.

Haul approved flexible base in clean trucks. Deliver the required quantity to each 100 foot station or designated stockpile site as shown on the plans. Prepare stockpile sites as directed. When delivery is to the 100 foot station, manipulate in accordance with the applicable Items.

**A. Preparation of Subgrade or Existing Base.** Remove or scarify existing asphalt concrete pavement in accordance with Item 104, "Street Excavation," when shown on the plans or as directed. Shape the subgrade or existing base to conform to the typical sections shown on the plans or as directed.

When new base is required to be mixed with existing base, deliver, place, and spread the new flexible base in the required amount per station. Manipulate and thoroughly mix the new base with existing material to provide a uniform mixture to the specified depth before shaping.

When shown on the plans or directed, proof roll the roadbed in accordance with TxDOT Item 216, "Proof Rolling," before pulverizing or scarifying. Correct soft spots as directed.

**B. Placing.** Spread and shape flexible base into a uniform layer with an approved spreader the same day as delivered unless otherwise approved. Construct layers to the thickness shown on the plans. Maximum lift thickness shall be 10 inches of loose material. Maintain the shape of the course. Control dust by sprinkling, as directed. Correct or replace segregated areas as directed, at no additional expense to the City.

Place successive base courses and finish courses using the same construction methods required for the first course.

**C. Compaction.** Compact in courses not to exceed 8 inches compacted depth using density control unless otherwise shown on the plans. Multiple lifts are permitted when shown on the plans or approved. Bring each layer to the moisture content directed. When necessary, sprinkle the material in accordance with TxDOT Item 204, "Sprinkling."

Begin rolling longitudinally at the sides and proceed towards the center, overlapping on successive trips by at least ½ the width of the roller unit. On superelevated curves, begin rolling at the low side and progress toward the high side. Offset alternate trips of the roller. Operate rollers at a speed between 2 and 6 mph as directed.

Rework, recompact, and refinish material that fails to meet or that loses required moisture, density, stability, or finish before the next course is placed or the project is accepted. Continue work until specification requirements are met. Perform the work at no additional expense to the City.

**1. Ordinary Compaction.** Roll with approved compaction equipment as directed. Correct irregularities, depressions, and weak spots immediately by scarifying the areas affected, adding or removing approved material as required, reshaping, and recompacting.

- 2. Density Control.** Compact to at least 95% of the maximum density determined by TxDOT's standard laboratory test procedure Tex-113-E unless otherwise shown on the plans. Determine the moisture content of the material at the beginning and during compaction in accordance with TxDOT's standard laboratory test procedure Tex-103-E.

The Engineer will determine roadway density of completed sections in accordance with TxDOT's standard laboratory test procedure Tex-115-E. The Engineer may accept the section if no more than 1 of the 5 most recent density tests is below the specified density and the failing test is no more than 3 pounds per cubic foot below the specified density.

- D. Finishing.** After completing compaction, clip, skin, or tight-blade the surface with a maintainer or subgrade trimmer to a depth of approximately  $\frac{1}{4}$  inch. Remove loosened material and dispose of it at an approved location. Seal the clipped surface immediately by rolling with a pneumatic tire roller until a smooth surface is attained. Add small increments of water as needed during rolling. Shape and maintain the course and surface in conformity with the typical sections, lines, and grades as shown on the plans or as directed.

In areas where surfacing is to be placed, correct grade deviations greater than  $\frac{1}{4}$  inch in 16 feet measured longitudinally or greater than  $\frac{1}{4}$  inch over the entire width of the cross-section. Correct by loosening, adding, or removing material. Reshape and recompact in accordance with Section 200.4.C, "Compaction."

- E. Curing.** Cure the finished section until the moisture content is at least 3 percentage points below and above optimum or as directed before applying the next successive course or prime coat.

- 200.5. MEASUREMENT:** Flexible base will be measured by the square yard method per thickness shown in the proposal.

Measurement by the square yard is a plans quantity measurement. The quantity to be paid for is the quantity shown in the proposal unless modified by the Engineer. Additional measurements or calculations will be made if adjustments of quantities are required.

Measurement is further defined for payment by the square yard of surface area in the completed and accepted final position. The surface area of the base course is based on the width of flexible base as shown on the plans.

- 200.6. PAYMENT:** The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for the types of work shown below. No additional payment will be made for thickness or width exceeding that shown on the typical section or provided on the plans for square yard measurement.

Sprinkling and rolling will not be paid for directly but will be subsidiary to this Item unless otherwise shown on the plans.

Where subgrade is constructed under this Contract (Subgrade Treatment), correction of soft spots in the subgrade will be at the Contractor's expense. Where subgrade is not constructed under this project, correction of soft spots in the subgrade will be paid in accordance with pertinent Items.

Payment will be made for the type and grade specified. For square yard measurement, a depth will be specified. This price is full compensation for furnishing materials, temporary stockpiling, assistance provided in stockpile sampling and operations to level stockpiles for measurement,

loading, hauling, delivery of materials, spreading, blading, mixing, shaping, placing, compacting, reworking, finishing, correcting locations where thickness is deficient, curing, furnishing scales and labor for weighing and measuring, and equipment, labor, tools, and incidentals.

**200.7. BID ITEM:**

Item 200.1 - per square yard per 8 inches compacted depth

## ITEM

### 202 PRIME COAT

**202.1. DESCRIPTION:** *This item shall govern for the application of asphaltic material on the completed base course and/or other areas in accordance with this specification and as directed by the Engineer. Apply blotter material as required.*

**202.2. MATERIALS:** Provide materials in accordance with the following requirements:

**A. Bituminous.** Unless the type and grade are shown on the plans, utilize an MC-30 or AE-P asphalt cement in accordance with Item 300, "Asphalts, Oils, and Emulsions" of the Standard Specifications of the Texas Department of Transportation for prime coat. Where Emulsified Asphalts are used, the amount of emulsified asphalt as a percentage by volume of the total mixture shall be within the limits shown on the plans, or shall be of a percentage as directed by the Engineer.

**B. Blotter.** Unless otherwise shown on the plans or approved, use either base course sweepings obtained from cleaning the base or sand as blotter materials.

**202.3. EQUIPMENT:** Provide applicable equipment in accordance with this specification or as specified on the plans.

**A. Distributor.** Furnish a distributor that will apply the asphalt material uniformly at the specified rate or as directed.

**1. Transverse Variance Rate.** When a transverse variance rate is shown on the plans, confirm that the nozzles outside the wheel paths will output a predetermined percentage more of asphalt material by volume than the nozzles over the wheel paths.

**2. Calibration.**

**a. Transverse Distribution.** Furnish a distributor test report, no more than 1 year old, documenting that the variation in output for individual nozzles of the same size does not exceed 10% when tested at the greatest shot width in accordance with Tex-922-K, "Calibrating Asphalt Distribution Equipment," Part III.

Include the following documentation on the test report:

- the serial number of the distributor,
- a method that identifies the actual nozzle set used in the test, and
- the fan width of the nozzle set at a 12 inch bar height.

When a transverse variance rate is required, perform the test using the type and grade of asphalt material to be used on the project. The Engineer may verify the transverse rate and distribution at any time. If verification does not meet the requirements, correct deficiencies and furnish a new test report.

**B. Tank Volume.** Furnish a volumetric calibration and strap stick for the distributor tank in accordance with Tex-922-K, "Calibrating Asphalt Distribution Equipment," Part I.

Calibrate the distributor within the previous 3 years of the date first used on the project. The Engineer may verify calibration accuracy in accordance with Tex-922-K, "Calibrating Asphalt Distribution Equipment," Part II.

- C. **Computerized Distributor.** When paying for asphalt material by weight, the Engineer may allow use of the computerized distributor display to verify application rates. Verify application rate accuracy at a frequency acceptable to the Engineer.
- D. **Broom.** Furnish rotary, self-propelled brooms.
- E. **Rollers.** Rollers provided shall meet the requirements for their type as shown in Item 210, "Rollers."
- F. **Asphalt Storage and Handling Equipment.** When the plans or the Engineer allows storage tanks, furnish a thermometer in each tank to indicate the asphalt temperature continuously.

Keep equipment clean and free of leaks. Keep asphalt material free of contamination.

- G. **Digital Measuring Instrument.** Furnish a vehicle with a calibrated digital-measuring instrument accurate to  $\pm 6$  ft. per mile.

#### 202.4. CONSTRUCTION:

- A. **General.** Apply the mixture when the air temperature is 60°F and above, or above 50°F and rising. Measure the air temperature in the shade away from artificial heat. The Engineer will determine when weather conditions are suitable for application.

Do not permit traffic, hauling, or placement of subsequent courses over freshly constructed prime coats. Maintain the primed surface until placement of subsequent courses or acceptance of the work.

- B. **Surface Preparation.** Prepare the surface by sweeping or other approved methods. When directed, before applying bituminous material, lightly sprinkle the surface with water to control dust and ensure absorption.

- C. **Application.**

- 1. **Bituminous.** The Engineer will select the application temperature within the limits recommended in Item 300, "Asphalts, Oils, and Emulsions." Apply material within 15°F of the selected temperature.

Unless otherwise shown on the plans, prime coat shall be applied at a rate not to exceed 0.20 gallon per square yard of surface. The prime coat shall be applied evenly and smoothly, under a pressure necessary for proper distribution.

When emulsified asphalts are used as prime coat, agitate the water and emulsified asphalt to produce a uniform blend. Evenly distribute, at the rate specified, to locations shown on the plans or as directed. Regulate the percentage of emulsified asphalt in the mixture and distribute successive applications to achieve the specified rate, if necessary.

During the application of prime coat, care shall be taken to prevent splattering of adjacent pavement, curb and gutters or structures. When directed, roll the freshly applied prime coat with a pneumatic-tire roller to ensure penetration.

2. **Blotter.** Spread blotter material before allowing traffic to use a primed surface. When “Prime Coat and Blotter” is shown on the plans as a bid item, apply blotter material to primed surface at the rate shown in the plans or as directed. When “Prime Coat” is shown on the plans as a bid item, apply blotter to spot locations or as directed to accommodate traffic movement through the work area. Remove blotter material before placing the surface. Dispose of blotter material according to applicable state and federal requirements.
- 202.5. MEASUREMENT:** The asphaltic material for prime coat will be measured at the point of delivery on the project in gallons at the applied temperature. The quantity to be paid for shall be the number of gallons of asphaltic material used, as directed, in the accepted prime coat to the pay limits as shown on the plans. When emulsions are used, only that percentage of emulsified asphalt as a percentage by volume of the total mixture shall be paid for by the gallon of asphaltic material used in the accepted prime coat. Water used will not be measured for payment.
- 202.6. PAYMENT:** The work performed and materials furnished in accordance with this Item and measured as provided under “Measurement” will be paid for at the unit price bid for “Prime Coat” or “Prime Coat and Blotter” of the type and grade of bituminous material specified. This price is full compensation for cleaning and sprinkling the area to be primed; materials, including blotter material; and rolling, equipment, labor, tools, and incidentals.
- 202.7. BID ITEM:**
- Item 202.1 - Prime Coat - per gallon

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**ITEM****203 TACK COAT**

**203.1. DESCRIPTION:** *Apply asphaltic material on the completed base course after the prime coat has sufficiently cured, existing pavement, bituminous surface, or in the case of a bridge, on the prepared floor slab in accordance with these specifications and/or as directed by the Engineer.*

**203.2. MATERIALS:** The asphaltic material used for Tack Coat shall meet the requirements for “Asphalt Cement”, “Cut-Back Asphalt” or “Emulsified Asphalt” in Item No. 300, “Asphalts, Oils and Emulsions” of the Texas Department of Transportation Standard Specifications. The asphaltic material used for Tack Coat shall be the type or grade shown in the referring specification, or on the plans, or as directed/approved by the Engineer.

**203.3. EQUIPMENT:** Provide equipment that conforms to the requirements of Item 202, “Prime Coat,” Part 3, “Equipment.”

**203.4. CONSTRUCTION:** Before the tack coat is applied, the surface shall be cleaned thoroughly with a vacuum sweeper to the satisfaction of the Engineer. The asphaltic material shall be applied on the clean surface by an approved type of self-propelled pressure distributor evenly and smoothly under a pressure necessary for proper distribution.

The tack coat shall be applied at the rate specified by the referring specification or on the plans. Unless otherwise stated or allowed by the Engineer the application rate shall not exceed 0.10 gallon per square yard of surface.

Where the pavement mixture will adhere to the surface on which it is to be placed without the use of a tack coat, the tack coat may be eliminated by the Engineer. All contact surfaces of curbs and structures and all joints shall be painted with a thin uniform coat of the asphaltic material used for tack coat. During the application of tack coat, care shall be taken to prevent splattering of adjacent pavement, curb and gutters or structures.

**203.5. MEASUREMENT:** The asphaltic material for tack coat will be measured at point of delivery on the project in gallons at the applied temperature. The quantity to be paid for shall be the number of gallons of asphaltic material used, as directed, in the accepted tack coat. Water used with Emulsions will not be measured for payment.

**203.6. PAYMENT:** The work performed and materials furnished as prescribed by this item will be paid for at the contract unit price bid per gallon for “Tack Coat” which price shall be full compensation for cleaning the surface, for furnishing, heating, hauling and distributing the tack coat as specified; for all freight involved; and for all manipulations, labor, tools, equipment, and incidentals necessary to complete the work.

**203.7. BID ITEM:**

Item 203.1 - Tack Coat - per gallon

## ITEM

### 205 HOT MIX ASPHALTIC CONCRETE PAVEMENT

**205.1. DESCRIPTION:** *Construct a leveling-up course, a surface course or any combination of these courses as shown on the plans, each to be composed of a compacted mixture of mineral aggregate and asphaltic material. The pavement shall be constructed on the newly constructed subgrade or base course, existing pavement, bituminous surface or in the case of bridges, on the prepared floor slab, as herein specified and in accordance with the details shown on the plans.*

**205.2. MATERIALS:** Materials used in Hot Mix Asphaltic Concrete Pavement shall meet the requirements as set forth herein. If shown on the plans, materials may also meet the requirements as described in Item 340, "Dense-Graded Hot-Mix Asphalt (Method)" or Item 341, "Dense-Graded Hot-Mix Asphalt (QC/QA)" of the Texas Department of Transportation Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges.

Unless otherwise shown on the plans, provide aggregates that meet the aggregate quality requirements of TxDOT's Bituminous Rated Source Quality Catalog (BRSQC). Unapproved sources may be used if accepted by the Engineer and approved prior to use.

Furnish aggregates from sources that conform to the requirements shown in Table 1 herein, and as specified in this Section, unless otherwise shown on the plans. Provide aggregate stockpiles that meet the definition in this Section for either a coarse aggregate or fine aggregate. When reclaimed asphalt pavement (RAP) is used, provide RAP stockpiles in accordance with this Section. Aggregate from RAP is not required to meet Table 1 requirements unless otherwise shown on the plans.

Document all test results on a mixture design report and submit to the Engineer for approval. The Engineer may perform tests on independent or split samples to verify Contractor mix design results. Stockpile aggregates for each source and type separately. Determine aggregate gradations for mixture design and production testing based on the washed sieve analysis given in TxDOT standard laboratory test procedure Tex-200-F, Part II. Do not add material to an approved stockpile from other sources, unless otherwise approved by the Engineer.

Unless otherwise shown on the plans, reclaimed asphalt pavement (RAP) may be used in asphalt pavement maintenance or rehabilitation applications and shall be limited to a maximum of 20% RAP for surface or wearing courses and 30% RAP for courses below the surface or wearing course. Higher percentages of RAP may be used if requested in writing and approved by the Engineer prior to use.

**A. Coarse Aggregate.** Coarse aggregate stockpiles must have no more than 20% passing the #8 sieve. Provide aggregates with a surface aggregate classification (SAC) as shown below:

<u>Street Classification</u>	<u>Minimum Surface Aggregate Classification</u>
Primary and Secondary Arterials	A
Collector and Local Type B Streets	B
Local Type A Street With Bus Traffic	B
Local Type A Street Without Bus Traffic	C

SAC requirements apply only to aggregates used on the surface of travel lanes, unless otherwise shown on the plans. Blending aggregates to meet SAC criteria is allowable. Class B aggregate meeting all other requirements in Table 1 may be blended with a Class A aggregate in order to meet requirements for Class A materials. When blending Class A and B aggregates to meet a Class A requirement, ensure that at least 50% by weight of the material retained on the No. 4 sieve comes from the Class A aggregate source. Blend by volume if the bulk specific gravities of the Class A and B aggregates differ by more than 0.300. When blending, do not use Class C or D aggregates. For blending purposes, coarse aggregate from RAP will be considered as Class B aggregate.

- B. Reclaimed Asphalt Pavement (RAP).** RAP is defined as a salvaged, pulverized, broken or crushed asphalt pavement. The RAP to be used in the mix shall be crushed or broken to the extent that 100% will pass the two inch sieve.

The stockpiled RAP shall not be contaminated by dirt or other objectionable materials. Unless otherwise shown on the plans, stockpiled, crushed RAP shall have a decantation of 5% or less and a plasticity index of eight (8) or less, when tested in accordance with TxDOT standard laboratory test procedures Tex-406-A, Part I, and Tex-106-E, respectively. This requirement applies to stockpiles from which the asphalt has not been removed by extraction. When RAP is used, determine asphalt content and gradation for mixture design purposes.

- C. Fine Aggregate.** Fine aggregates may consist of manufactured sands, screenings and field sands. Supply fine aggregates that are free from organic impurities. Field sands and other uncrushed aggregates shall be limited to 15% of the total aggregate.

If 10% or more of the fine aggregate stockpile is retained on the No. 4 sieve, test the stockpile and verify that it meets the requirements in Table 1 for coarse aggregate angularity (TxDOT standard laboratory test procedure Tex-460-A) and flat and elongated particles (TxDOT standard laboratory test procedure Tex-280-F).

- D. Asphalt Binder.** Unless shown on the plans, provide the type and grade of performance-graded asphalt binder in accordance with TxDOT Item 300.2.J. “Performance-Graded Binders” and as specified below:

Street Classification	Minimum PG Asphalt Cement Grade		
	Surface Courses	Binder & Level Up Courses	Base Courses
Primary and Secondary Arterials	PG 76-22	PG 70-22	PG 64-22
Collector and Local Type B Streets	PG 70-22		
Local Type A Street With Bus Traffic		PG 64-22	
Local Type A Street Without Bus Traffic	PG 64-22		

- E. Mineral Filler.** Mineral filler consists of finely divided mineral matter such as agricultural lime, crusher fines, hydrated lime, cement, or fly ash. Mineral filler is allowed unless otherwise shown on the plans. Do not use more than 2% hydrated lime or cement, unless otherwise shown on the plans. The plans may require or disallow specific mineral fillers. When used, provide mineral filler that:

- is sufficiently dry, free-flowing, and free from clumps and foreign matter;

- does not exceed 3% linear shrinkage when tested in accordance with Tex-107-E; and
  - meets the gradation requirements of Table 3 herein.
- F. Baghouse Fines.** Fines collected by the baghouse or other dust collecting equipment may be reintroduced into the mixing drum.
- G. Tack Coat.** Unless otherwise shown on the plans or approved, furnish CSS-1H, SS-1H, or a PG binder with a minimum high-temperature grade of PG 58 for tack coat binder and in accordance with Item 203, “Tack Coat.” Do not dilute emulsified asphalts at the terminal, in the field, or at any other location before use.
- H. Additives.** When shown on the plans, use the type and rate of additive specified. Other additives that facilitate mixing or improve the quality of the mixture may be allowed when approved. If lime or a liquid antistripping agent is used, add in accordance with TxDOT Item 301, “Asphalt Antistripping Agents.” Do not add lime directly into the mixing drum of any plant where lime is removed through the exhaust stream, unless the plant has a baghouse or dust collection system that reintroduces the lime back into the drum.

**Table 1**  
**Aggregate Quality Requirements**

Property	TxDOT Standard Laboratory Test Procedure	Surface Courses	Binder, Level Up, & Base Courses
<b>Coarse Aggregate</b>			
Deleterious Material, %, max	Tex-217-F, Part I	1.0	1.5
Decantation, %, max	Tex-217-F, Part II	1.5	1.5
Micro-Deval Abrasion, %, max	Tex-461-A	Screening Only	Screening Only
Los Angeles Abrasion, %, max	Tex-410-A	35	40
Magnesium Sulfate Soundness, 5 cycles, %, max	Tex-411-A	25	30
Coarse Aggregate Angularity, 2 crushed faces, %, min	Tex-460-A, Part I	95 <sup>1</sup>	85 <sup>1</sup>
Flat and Elongated Particles @ 5:1, %, max	Tex-280-F	10	10
<b>Fine Aggregate</b>			
Linear Shrinkage, %, max	Tex-107-E	3	3
<b>Combined Aggregate<sup>2</sup></b>			
Sand Equivalent, %, min	Tex-203-F	45	45

Note 1: Applies to Gravel Only

Note 2: Aggregate without mineral filler, RAP, or additives combined as used in the job-mixed formula (JMF)

**Table 2**  
**Gradation Requirements for Fine Aggregates**

Sieve Size, in	% Passing by Weight or Volume
3/8	100
#8	70 – 100
#200	0 – 30

**Table 3**  
**Gradation Requirements for Mineral Filler**

Sieve Size, in	% Passing by Weight or Volume
#8	100
#200	55 – 100

**205.3. EQUIPMENT:** All equipment for the handling of all materials, mixing, placing and compacting of the mixture shall be maintained in good repair and operating condition and subject to the approval of the Engineer. Any equipment found to be defective and potentially having a negative effect on the quality of the paving mixture or ride quality will not be allowed.

**A. Spreading and Finishing Machine.** The spreading and finishing machine shall be approved by the Engineer and shall meet the requirements indicated below.

- 1. Screed Unit.** The spreading and finishing machine shall be equipped with a heated compacting screed. It shall produce a finished surface meeting the requirements of the typical cross sections and the surface test.

Extensions added to the screed shall be provided with the same compacting action and heating capability as the main screed unit, except for use on variable depth tapered areas and/or as approved by the Engineer.

The spreading and finishing machine shall be equipped with an approved automatic dual longitudinal screed control system and automatic transverse screed control system. The longitudinal controls shall be capable of operating from any longitudinal grade reference including a stringline, ski, mobile stringline, or matching shoe.

The Contractor shall furnish all equipment required for grade reference. It shall be maintained in good operating condition by personnel trained in the use of this type of equipment.

The grade reference used by the Contractor may be of any type approved by the Engineer. The contractor shall set the grade reference to have sufficient support so that the maximum deflection shall not exceed 1/16 inch between supports.

- 2. Tractor Unit.** The tractor unit shall be equipped with a hydraulic hitch sufficient in design and capacity to maintain contact between the rear wheels of the hauling equipment and the pusher rollers of the finishing machine while the mixture is being unloaded.

No portion of the weight of hauling equipment, other than the connection, shall be supported by the asphalt paver. No vibrations or other motions of the loading equipment, which could have a detrimental effect on the riding quality of the completed pavement, shall be transmitted to the paver.

The use of any vehicle which requires dumping directly into the finishing machine and which the finishing machine cannot push or propel to obtain the desired lines and grades without resorting to hand finishing will not be allowed.

**B. Material Transfer Equipment.** Equipment to transfer mixture from the hauling units or the roadbed to the spreading and finishing machine will be allowed unless otherwise shown on the plans. A specific type of material transfer equipment shall be required when shown on the plans.

**C. Motor Grader.** The motor grader, when used, shall meet the requirements as shown in Item 220, "Blading."

**D. Rollers.** Rollers provided shall meet the requirements for their type as shown in Item 210, "Rolling."

**205.4. CONSTRUCTION:** It shall be the responsibility of the Contractor to design, produce, transport, place and compact the specified paving mixture in accordance with the requirements herein. The Engineer will perform verification testing as needed. Provide quality control (QC) testing as needed to meet the requirements of this Item. Provide a certified Level I-A specialist at the plant during production hours. Provide a certified Level I-B specialist to conduct placement tests.

**A. Quality Control Plan (QCP).** Unless otherwise shown on the plans, develop and follow a QCP. Obtain approval from the Engineer for changes to the QCP made during the project. The Engineer may suspend operations if the Contractor fails to comply with the QCP.

Submit a written QCP to the Engineer and receive the Engineer's approval of the QCP before beginning production. Include the following items in the QCP.

**1. Project Personnel.** Provide:

- a. a list of individuals that will conduct tests as well their associated certifications (i.e. Level IA, IB, and II certifications), including when certifications will expire for each individual; and
- b. a list of individuals responsible for QC with authority to take corrective action and the contact information for each individual listed.

**2. Material Delivery and Storage.** Provide:

- a. the sequence of material processing, delivery, and minimum quantities to assure continuous plant operations;
- b. aggregate stockpiling procedures to avoid contamination and segregation;
- c. frequency, type, and timing of aggregate stockpile testing to assure conformance of material requirements before mixture production; and
- d. procedure for monitoring the quality and variability of asphalt binder.

**3. Production.** Detail:

- a. loader operation procedures to avoid contamination in cold bins;
- b. procedures for calibrating and controlling cold feeds;
- c. procedures to eliminate debris or oversized material;
- d. procedures for adding and verifying rates of each applicable mixture component (e.g., aggregate, asphalt binder, RAP, lime, liquid antistriper);
- e. procedures for reporting job control and acceptance test results; and
- f. procedures to avoid segregation and drain-down in the silo.

**4. Loading and Transporting.** Provide:

- a. the type and application method for release agents; and

- b. truck loading procedures to avoid segregation.

**5. Placement and Compaction.** Provide:

- a. the proposed agenda for mandatory pre-paving meeting including date and location;
- b. the type and application method for release agents in the paver and on rollers, shovels, lutes, and other utensils;
- c. procedures for the transfer of mixture into the paver while avoiding segregation and preventing material spillage;
- d. the process to balance production, delivery, paving, and compaction to achieve continuous placement operations;
- e. the paver operations (e.g., operation of wings, height of mixture in auger chamber) to avoid physical and thermal segregation and other surface irregularities; and
- f. procedures to construct quality longitudinal and transverse joints.

- B. Mixture Design.** Use a Level II specialist certified by a TxDOT-approved hot-mix asphalt certification program to develop the mixture design. Have the Level II specialist sign the design documents. Unless otherwise shown on the plans, use the typical weight design example given in TxDOT standard laboratory test procedure Tex-204-F, Part I or Part III, to design a mixture meeting the requirements listed in Tables 1 through 5. At the request of the Engineer, furnish representative samples of all materials used in the mixture design for verification. If the design cannot be verified by the Engineer, furnish another mixture design.

The Contractor may submit a new mixture design at anytime during the project. The Engineer will approve all mixture designs before the Contractor can begin production.

Provide the Engineer with a mixture design report that includes the following items:

- the combined aggregate gradation, source, specific gravity, and percent of each material used;
- results of all applicable tests;
- the mixing and molding temperatures;
- all applicable correlation and correction factors;
- the signature of the Level II person or persons who performed the design;
- the date the mixture design was performed; and
- a unique identification number for the mixture design.

The Hamburg Wheel Test is not required, unless otherwise shown on the plans. When required through plan note, the minimum number of passes shown in Table 6 shall be met, unless otherwise approved by the Engineer. The contractor will be responsible for submitting the results of the Hamburg Wheel test to the Engineer with the other mixture design data. Use an approved laboratory to perform the Hamburg Wheel test. The TxDOT Construction

Division maintains a list of approved laboratories that may be referenced. Hamburg Wheel Testing will not be performed or required for any Type “F” mixtures.

**Table 4**  
**Master Gradation Bands (% Passing by Weight or Volume) and Volumetric Properties**

Sieve Size	A Coarse Base	B Fine Base	C Coarse Surface	D Fine Surface	F Fine Mixture
1-1/2”	98.0–100.0	–	–	–	–
1”	78.0–94.0	98.0–100.0	–	–	–
3/4”	64.0–85.0	84.0–98.0	95.0–100.0	–	–
1/2”	50.0–70.0	–	–	98.0–100.0	–
3/8”	–	60.0–80.0	70.0–85.0	85.0–100.0	98.0–100.0
#4	30.0–50.0	40.0–60.0	43.0–63.0	50.0–70.0	70.0–90.0
#8	22.0–36.0	29.0–43.0	32.0–44.0	35.0–46.0	35.0–50.0
#30	8.0–23.0	13.0–28.0	14.0–28.0	15.0–29.0	12.0–27.0
#50	3.0–19.0	6.0–20.0	7.0–21.0	7.0–20.0	6.0–19.0
#200	2.0–7.0	2.0–7.0	2.0–7.0	2.0–7.0	2.0–7.0
<b>Design Voids in the Mineral Aggregate (VMA), % minimum</b>					
	12.0	13.0	14.0	15.0	16.0
<b>Plant-Produced Voids in the Mineral Aggregate (VMA), % minimum</b>					
	11.0	12.0	13.0	14.0	15.0

**Table 5**  
**Laboratory Mixture Design Properties**

Property	TxDOT Standard Laboratory Test Procedure	Required	
Target laboratory-molded density, %	Tex-207-F	96.5	Base, Binder, and Level Up Courses
		<b>Surface or Wearing Courses</b>	
		96.5	Primary and Secondary Arterials
		97.0	Collectors, Local Type B Streets, and Local Type A Street With Bus Traffic
		97.5	Local Type A Street Without Bus Traffic
Boil test <sup>1</sup>	Tex-530-C	–	

1. Used to establish baseline for comparison to production results. May be waived when approved.

**Table 6**  
**Hamburg Wheel Test Requirements<sup>1</sup>**

High-Temperature Binder Grade	Minimum # of Passes <sup>2</sup> @ 0.5" Rut Depth, Tested @ 122°F
PG 64 or lower	5,000
PG 70	10,000
PG 76 or higher	20,000

1. Tested in accordance with Tex-242-F.

2. May be decreased if shown on the plans.

**C. Job-Mix Formula.** The laboratory mixture design shall be submitted to the Engineer for approval prior to production and placement. The submittal shall provide the laboratory

designed mixture target properties and data that demonstrate the contractor's ability to produce the mixture within the tolerances specified in Table 7 herein either through a trial batch or by submittal of previous production data from a City or TxDOT project.

Once approved, the contractor may begin production and placement of the approved JMF. Results from Lot 1 of the JMF may be used to modify the optimum mixture properties as long as the tested properties are within the tolerances specified in Table 7 herein. Further adjustments to the JMF may be allowed by the Engineer during production and placement, if warranted. JMF adjustment requests must be made in writing to the Engineer and the mixture must conform to the master gradation limits for the mixture type and be within the operational limits of Table 7 noted above for the initial JMF approved by the Engineer.

**Table 7**  
**Operational Tolerances**

Description	Test Method	Allowable Difference from Current JMF Target
Individual % Retained for #8 Sieve or Larger	Tex-200-F or Tex-236-F	±5.0 <sup>1</sup>
Individual % Retained for Sieves Smaller than #8 and Larger than #200		±3.0 <sup>1</sup>
% Passing the #200 Sieve		±2.0 <sup>1</sup>
Asphalt Content, %	Tex-236-F	±0.3 <sup>2</sup>
Laboratory-Molded Density, %	Tex-207-F	±1.0
VMA, % minimum		Note 3

Note 1: When within these tolerances, mixture production gradations may fall outside the master grading limits; however, the % passing the #200 sieve will be considered out of tolerance when outside the master grading limits.

Note 2: Tolerance between Laboratory Mix and Plant Trial Batch may exceed ±0.3.

Note 3: Test and verify that Table 4 requirements are met.

- D. Production.** Do not heat the asphalt binder above the temperatures specified in TxDOT Item 300, "Asphalts, Oils, and Emulsions," or outside the manufacturer's recommended values. Do not store an asphaltic mixture for a period long enough to affect the quality of the mixture, nor in any case longer than 12 hr.

Notify the Engineer of the target discharge temperature and produce the mixture within 25°F of the target. Monitor the temperature of the material in the truck before shipping to ensure that it does not exceed 350°F. The Engineer will not pay for, or allow placement of, any mixture produced at more than 350°F. Control the mixing time and temperature so that moisture is removed from the mixture before discharging from the plant. If requested, determine the moisture content by oven-drying in accordance with TxDOT standard laboratory test procedure Tex-212-F, Part II, and verify that the mixture contains no more than 0.2% of moisture by weight. Obtain the sample immediately after discharging the mixture into the truck, and perform the test promptly.

Perform a new trial batch when the plant or plant location is changed. The Engineer may suspend production for noncompliance with this Item. Take corrective action and obtain approval to proceed after any production suspension for noncompliance.

- E. Tack Coat.** The surface upon which the tack coat is to be placed shall be cleaned thoroughly to the satisfaction of the Inspector. The surface shall be given a uniform application of tack coat using asphaltic materials of this specification. Unless otherwise shown on the plans, tack

coat shall be applied with an approved sprayer at a rate directed by the Engineer between 0.04 and 0.10 gallon residual asphalt per square yard of surface.

**F. Transporting Asphaltic Concrete.** The asphaltic mixture shall be hauled to the work site in vehicles previously cleaned of all foreign material and with beds that do not discharge or lose materials during the haul. Trucks that do not meet the satisfaction of the Engineer or Inspector will not be allowed to deliver materials to City projects. The dispatching of the vehicles shall be arranged so that all material is delivered, placed, and rolled during daylight hours unless otherwise shown on the plans. In cool weather, or for long hauls, covering and insulating of the truck bodies may be required. If necessary, to prevent the mixture from adhering to the inside of the truck body, the inside of the truck may be given a light coating of release agent satisfactory to the Engineer.

**G. Placement.**

**1. Weather Conditions.** Place mixture, when placed with a spreading and finishing machine, or the tack coat when the roadway surface temperature is 60°F or higher unless otherwise approved. Measure the roadway surface temperature with a handheld infrared thermometer. Place mixtures only when weather conditions and moisture conditions of the roadway surface are suitable in the opinion of the Engineer.

The asphaltic mixture, when placed with a motor grader, shall not be placed when the surface temperature is below 65°F and is falling, but may be placed when the surface temperature is above 55°F and is rising. The maximum depth of asphalt mixture placed with a motor grader will not exceed 5 inches of compacted material.

Mat thicknesses of 1-½ inches and less shall not be placed when the temperature of the surface on which the mat is to be placed is below 60°F.

It is further provided that the tack coat or asphaltic mixture shall be placed only when the humidity, general weather conditions, temperature and moisture condition of the base are suitable.

**2. Placement Temperature.** If, after being discharged from the mixer and prior to placing, the temperature of the asphaltic mixture falls below 200°F, all or any part of the load may be rejected and payment will not be made for the rejected material.

**3. Placement Operations.** Placement and laydown operations shall be in conformance with this section and Section 205.4.H. - "Quality Control and Acceptance."

Prepare the surface by removing raised pavement markers and objectionable material such as moisture, dirt, sand, leaves, and other loose impediments from the surface before placing mixture. Remove vegetation from pavement edges.

The asphaltic mixture shall be dumped and spread on the approved prepared surface with the spreading and finishing machine. Place the mixture to meet the typical section requirements and produce a smooth, finished surface with a uniform appearance and texture. In addition, the placing of the asphaltic mixture shall be completed without tearing, shoving, gouging or segregating the mixture and without producing streaks in the mat.

Unloading into the finishing machine shall be controlled so that bouncing or jarring the spreading and finishing machine shall not occur and the required lines and grades shall be obtained without resorting to hand finishing.

When approved by the Engineer, level-up courses may be spread with a motor grader.

Construction joints of successive courses of asphaltic material shall be offset at least 6 inches. Construction joints on surface courses shall coincide with lane lines, or as directed by the Engineer.

The spreading and finishing machine shall be operated at a uniform forward speed consistent with the plant production rate, hauling capability, and roller train capacity to result in a continuous operation. The speed shall be slow enough that stopping between trucks is not ordinarily required. If, in the opinion of the Inspector, sporadic delivery of material is adversely affecting the mat, the Inspector may require paving operations to cease until acceptable methods are provided to minimize starting and stopping of the paver.

The hopper flow gates of the spreading and finishing machine shall be adjusted to provide an adequate and consistent flow of material. These shall result in enough material being delivered to the augers so that they are operating approximately 85 percent of the time or more. The augers shall provide means to supply adequate flow of material to the center of the paver. Augers shall supply an adequate flow of material for the full width of the mat, as approved by the Engineer. Augers should be kept approximately one-half to three-quarters full of mixture at all times during the paving operation.

When the asphaltic mixture is placed in a narrow strip along the edge of an existing pavement, or used to level up small areas of an existing pavement, or placed in small irregular areas where the use of a finishing machine is not practical, the finishing machine may be eliminated when authorized by the Engineer.

Adjacent to flush curbs, gutters and structures, the surface shall be finished uniformly high so that when compacted, it will be slightly above the edge of the curb or structure.

If a pattern of surface irregularities or segregation is detected, the Contractor shall make an investigation into the causes and immediately take the necessary action. With the approval of the Inspector, placement may continue for no more than one full production day from the time the Contractor is first notified and while corrective actions are being taken. If the problem still exists after that time, paving shall cease until the Contractor further investigates the causes and the Engineer approves further corrective action to be taken.

Place mixture within the compacted lift thickness shown in Table 8, unless otherwise shown on the plans or allowed.

Use the guidelines in Table 9 to establish the temperature of mixture delivered to the paver.

**Table 8**  
**Compacted Lift Thickness and Required Core Height**

Mixture Type	Compacted Lift Thickness		Minimum Untrimmed Core Height (in.) Eligible for Testing
	Minimum (in.)	Maximum (in.)	
A	3.00	6.00	2.00
B	2.50	5.00	1.75
C	2.00	4.00	1.50
D	1.50	3.00	1.25
F	1.25	2.50	1.25

**Table 9**  
**Suggested Minimum Mixture Placement Temperature**

High-Temperature Binder Grade	Minimum Placement Temperature (Before Entering Paver)
PG 64 or lower	260°F
PG 70	270°F
PG 76	280°F
PG 82 or higher	290°F

4. **Compaction.** The pavement shall be compacted thoroughly and uniformly with the necessary rollers to obtain the compaction and cross section of the finished paving mixture meeting the requirements of the plans and specifications.

The edges of the pavement along curbs, headers and similar structures, and all places not accessible to the roller, or in such positions as will not allow thorough compaction with the rollers, shall be thoroughly compacted with lightly oiled tamps.

Rolling with a trench roller will be required on widened areas, in trenches and other limited areas where satisfactory compaction cannot be obtained with the approved rollers.

- a. **In-Place Compaction Control.** Use density control unless ordinary compaction control is specified on the plans. Use the control strip method given in Tex-207-F, Part IV, to establish the rolling pattern for density controlled areas.

Where specific density or air void requirements are waived, furnish and operate compaction equipment as approved.

Do not use pneumatic-tire rollers if excessive pickup of fines by roller tires occurs. Unless otherwise directed, use only water or an approved release agent on rollers, tamps, and other compaction equipment. Keep diesel, gasoline, oil, grease, and other foreign matter off the mixture.

When rolling with the three-wheel, tandem or vibratory rollers, it is recommended that rolling start by first rolling the joint with the adjacent pavement and then continue by rolling longitudinally at the sides and proceed toward the center of the pavement, overlapping on successive trips by at least 1 foot. Alternate trips of the roller should be slightly different in length. On super-elevated curves, rolling should begin at the low side and progress toward the high side.

When rolling with vibratory steel-wheel rollers, equipment operation shall be in accordance with Item 210, "Rolling", and the manufacturer's recommendations, unless otherwise directed by the Engineer. Vibratory rollers shall not be left vibrating

while not rolling or when changing directions. In addition, vibratory rollers shall not be allowed in the vibrating mode on mats with a plan depth of less than 1-½ inches, unless approved by the Engineer.

The motion of the rollers shall be slow enough to avoid other than usual initial displacement of the mixture. If any displacement occurs, it shall be corrected to the satisfaction of the Inspector. Ensure pavement is fully compacted before allowing rollers to stand on the pavement.

**(1) Ordinary Compaction Control.** One three-wheel roller, one pneumatic-tire roller, and one tandem roller shall be furnished for each compaction operation except as provided below or approved by the Engineer. The use of a tandem roller may be waived by the Engineer when the surface is already adequately smooth and further steel-wheel rolling is shown to be ineffective. With approval of the Engineer, the Contractor may substitute a vibratory roller for the three-wheel roller and/or the tandem roller. Use of at least one pneumatic-tire roller is required unless approved by the Engineer. Additional or heavier rollers shall be furnished if required by the Engineer.

Rolling patterns shall be established by the Contractor to achieve the maximum compaction. The selected rolling pattern shall be followed unless changes in the mixture or placement conditions occur which affect compaction. When changes in the mixture or placement conditions occur, a new rolling pattern shall be established.

**(2) Density Compaction Control.** Place and compact asphaltic concrete materials in accordance with the method specified in Section 205.4.H, "Quality Control and Acceptance."

- 5. Compaction Cessation Temperature.** Regardless of the method required for in-place compaction control, all rolling for compaction shall be completed before the mixture temperature drops below 175°F.
- 6. Opening to Traffic.** Allow the compacted pavement to cool to 160°F or lower before opening to traffic unless otherwise directed. When directed, sprinkle the finished mat with water or limewater to expedite opening the roadway to traffic.

If the surface ravel, flushes, ruts or deteriorates in any manner prior to final acceptance of the work, it will be the Contractor's responsibility to correct this condition at their expense, to the satisfaction of the Inspector and in conformance with the requirements of this specification.

**H. Quality Control and Acceptance.** Control and acceptance of hot mixed asphaltic concrete pavement shall be followed as specified herein or as directed on the plans. The contractor shall conduct production and placement operations in accordance with the method specified. All testing will be conducted in accordance with the testing methods shown in Table 10.

**Table 10**  
**Acceptable Production and Placement Testing Methods**

Description	Test Method
Gradation including % passing the #200 sieve	Tex-200-F or Tex-236-F
Laboratory-molded density	Tex-207-F
VMA	
Laboratory-molded bulk specific gravity	
In-Place air voids	
Segregation (density profile)	Tex-207-F, Part V
Longitudinal joint density	Tex-207-F, Part VII
Moisture content	Tex-212-F, Part II
Theoretical maximum specific (Rice) gravity	Tex-227-F
Asphalt content	Tex-236-F
Hamburg Wheel test	Tex-242-F
Thermal profile	Tex-244-F
Asphalt binder sampling and testing <sup>1</sup>	Tex-500-C
Boil test <sup>1</sup>	Tex-530-C

1. The Engineer may waive the sampling and testing requirements at their discretion.

- 1. Production Sampling and Testing.** For a given project, sample asphaltic concrete materials at the production facility every 500 tons for each mixture type supplied or as directed by the Engineer. Unless otherwise shown on the plans, a production facility that supplies the same mixture to multiple City projects on the same day will not be required to sample and test at the required frequency for every project. A single test report may be used on two or more projects to represent the quality of the mixture for that day's production.

During production, do not exceed the operational tolerances in Table 7. Stop production if testing indicates tolerances are exceeded on:

- 3 consecutive tests on any individual sieve,
- 4 consecutive tests on any of the sieves, or
- 2 consecutive tests on asphalt content.

Suspend production and shipment of mixture if the asphalt content deviates from the current JMF by more than 0.5% for any test.

Begin production only when test results or other information indicate, to the satisfaction of the Engineer, that the next mixture produced will be within Table 7 tolerances.

The Contractor shall perform a Hamburg Wheel test at the direction of the Engineer at any time during production, including when the boil test indicates a change in quality from the materials submitted for the initial JMF. If the production sample fails the Hamburg Wheel test criteria in Table 6, suspend production until further Hamburg Wheel tests meet the specified values. The Engineer may require up to the entire subplot of any mixture failing the Hamburg Wheel test to be removed and replaced at the Contractor's expense.

If the Hamburg Wheel test results in a "remove and replace" condition, the Contractor may request that the Engineer confirm the results by retesting the failing material. An Independent laboratory retained by the Engineer will perform the Hamburg Wheel tests

and determine the final disposition of the material in question based on the initial test results.

## 2. Placement Sampling and Testing.

- a. **In-Place Density.** For every 500 tons of compacted asphaltic material or as directed by the Engineer, test the in place density. The in place density shall be in the range of 92.0% to 97.0% of the maximum density. Do not increase the asphalt content of the mixture to increase pavement density.

Unless otherwise shown on the plans, obtain 2 roadway specimens at each location selected by the Engineer for in-place density determination. Unless otherwise determined, the Engineer will witness the coring operation and measurement of the core thickness. Unless otherwise approved, obtain the cores within 1 working day after placement is completed. Obtain two 6 inch diameter cores side-by-side from within 1 foot of the location provided by the Engineer. For Type C, D and F mixtures, 4 inch diameter cores are allowed. Mark the cores for identification.

Visually inspect each core and verify that the current paving layer is bonded to the underlying layer. If an adequate bond does not exist between the current and underlying layer, take corrective action to insure that an adequate bond will be achieved during subsequent placement operations.

Immediately after obtaining the cores, dry the core holes and tack the sides and bottom. Fill the hole with the same type of mixture and properly compact the mixture. Repair core holes with other methods when approved.

If the core heights exceed the minimum untrimmed values listed in Table 8, trim the cores within 1 working day following placement operations unless otherwise approved. If the core height before trimming is less than the minimum untrimmed value shown in Table 8, decide whether or not to include the pair of cores in the density determination for that subplot. If the cores are to be included in density determination, trim the cores. If the cores will not be included in density determination, store untrimmed cores for the Engineer.

The Engineer will measure density in accordance with Tex-207-F and Tex-227-F. Before drying to a constant weight, cores may be predried using a vacuum device, or by other methods approved by the Engineer, to remove excess moisture. The Engineer will use the average density of the 2 cores to calculate the in-place density at the selected location.

If the in-place density in the compacted mixture is below 92% or greater than 97%, change the production and placement operations to bring the in-place density within requirements. The Engineer may suspend production until the in-place density is brought to the required level, and may require a test section as described below, before proceeding.

At the onset of production, or after production and placement operations have been altered to bring the in-place density into conformance, construct a test section of 1 lane-width and at most 0.2 miles in length to demonstrate that compaction to between 92.0% and 97.0% in-place density can be obtained. Continue this procedure until a test section with the correct density can be produced. The Engineer will allow only 2

test sections per day. When a test section producing satisfactory in-place air void content is placed, resume full production.

- (1) **Shoulders and Ramps.** Shoulders and ramps are subject to in-place density testing, unless otherwise shown on the plans.
- (2) **Miscellaneous Areas.** Miscellaneous areas include areas that are not generally subject to primary traffic, such as driveways, mailbox turnouts, crossovers, gores, spot level-up areas, and other similar areas. Miscellaneous areas also include level-ups and thin overlays if the layer thickness designated on the plans is less than the compacted lift thickness shown in Table 8.

Miscellaneous areas will not be included in the in place density testing. Compact areas that are not subject to in-place air void determination in accordance with ordinary compaction control.

- b. **Segregation (Density Profile).** If shown on the plans, test for segregation using density profiles in accordance with Tex-207-F, Part V. Provide the Engineer with the results of the density profiles as they are completed. Areas defined as “Miscellaneous Areas,” are not subject to density profile testing.

If density profiles are required by the plans, perform a density profile every time the screed stops, on areas that are identified by either the Contractor or the Engineer as having thermal segregation, and on any visibly segregated areas. If the screed does not stop, and there are no visibly segregated areas or areas that are identified as having thermal segregation, perform a minimum of 1 profile per 500 tons of compacted material or as directed by the Engineer.

Reduce the test frequency to a minimum of 1 profile per 2,000 tons of compacted material, or as directed by the Engineer, if 4 consecutive profiles are within established tolerances. Continue testing at this frequency unless a profile fails, at which point resume testing at a minimum frequency of 1 per 500 tons or as directed by the Engineer. The Engineer may further reduce the testing frequency based on a consistent pattern of satisfactory results.

Unless otherwise shown on the plans, the density profile is considered failing if it exceeds the tolerances in Table 11. No production or placement bonus will be paid for any subplot that contains a failing density profile. The Engineer may make as many independent density profile verifications as deemed necessary. The Engineer’s density profile results will be used when available.

Investigate density profile failures and take corrective actions during production and placement to eliminate the segregation. Suspend production if 2 consecutive density profiles fail, unless otherwise approved. Resume production after the Engineer approves changes to production or placement methods.

**Table 11**  
**Segregation (Density Profile) Acceptance Criteria**

Mixture Type	Maximum Allowable Density Range (Highest to Lowest)	Maximum Allowable Density Range (Average to Lowest)
Type A & Type B	8.0 pcf	5.0 pcf
Type C, Type D, & Type F	6.0 pcf	3.0 pcf

**c. Longitudinal Joint Density.**

- (1) Informational Tests.** While establishing the rolling pattern, perform joint density evaluations and verify that the joint density is no more than 3.0 pounds per cubic foot below the density taken at or near the center of the mat. Adjust the rolling pattern if needed to achieve the desired joint density. Perform additional joint density evaluations at least once per subplot unless otherwise directed.
- (2) Record Tests.** If shown on the plans, for each 500 tons of compacted material or as directed by the Engineer, perform a joint density evaluation at each pavement edge that is or will become a longitudinal joint. Determine the joint density in accordance with Tex-207-F, Part VII. Record the joint density information and submit results to the Engineer. The evaluation is considered failing if the joint density is more than 3.0 pounds per cubic foot below the density taken at the core random sample location and the correlated joint density is less than 90.0%. The Engineer may make independent joint density verifications at the random sample locations. The Engineer's joint density test results will be used when available.

Investigate joint density failures and take corrective actions during production and placement to improve the joint density. Suspend production if 2 consecutive evaluations fail unless otherwise approved. Resume production after the Engineer approves changes to production or placement methods.

- d. Recovered Asphalt DSR.** The Engineer may take production samples or cores from suspect areas of the project to determine recovered asphalt properties. Asphalt binders with an aging ratio greater than 3.5 do not meet the requirements for recovered asphalt properties and may be deemed defective when tested and evaluated by the Engineer. The aging ratio is the dynamic shear rheometer (DSR) value of the extracted binder divided by the DSR value of the original unaged binder (including RAP binder). DSR values are obtained according to AASHTO T 315 at the specified high temperature performance grade of the asphalt. The binder from RAP will be included proportionally as part of the original unaged binder. The Engineer may require removal and replacement of the defective material at the Contractor's expense. The asphalt binder will be recovered for testing from production samples or cores using Tex-211-F.
- e. Irregularities.** Immediately take corrective action if surface irregularities, including but not limited to segregation, rutting, raveling, flushing, fat spots, mat slippage, color, texture, roller marks, tears, gouges, streaks, or uncoated aggregate particles, are detected.

The Engineer may allow placement to continue for at most 1 day of production while taking appropriate action. If the problem still exists after that day, suspend paving until the problem is corrected to the satisfaction of the Engineer.

At the expense of the Contractor and to the satisfaction of the Engineer, remove and replace any mixture that does not bond to the existing pavement or that has other surface irregularities identified above.

- 3. Individual Loads of Hot Mix.** The Engineer can reject individual truckloads of hot mix. When a load of hot mix is rejected for reasons other than temperature, the Contractor may request that the rejected load be tested. Make this request within 4 hr. of rejection. The Engineer will sample and test the mixture. If test results are within the operational tolerances shown in Table 7, payment will be made for the load. If test results are not within operational tolerances, no payment will be made for the load and the Engineer may require removal.
  - 4. Ride Quality.** When required by the plans, measure ride quality in accordance with TxDOT Standard Specification Item 585, "Ride Quality for Pavement Surfaces." Surface Test Type A or B as well as Pay Schedule 1, 2, or 3 shall also be indicated on the plans.
- 205.5. MEASUREMENT:** Hot Mix Asphaltic Concrete Pavement shall be measured by square yard, complete in place, for the thickness specified on the plans. Limits of payment will be from face of curb to face of curb. Pavement area shall not exceed the limits shown on the plans without written authorization.
- 205.6. PAYMENT:** The work performed and materials furnished, as described by this item and measured as provided herein, shall be paid for at the contract unit bid price per square yard specified on the plans of "Hot Mix Asphaltic Concrete Pavement," which price shall be full compensation for furnishing and placing all materials, and for all labor, tools, equipment, and incidentals necessary to complete the work. The prime coat and tack coat, when required, shall be paid under the provisions of Item Nos. 202 and 203, respectively.

Trial batches will not be paid for unless they are incorporated into pavement work approved by the Engineer.

Pay adjustment for ride quality, when required on the plans, will be determined in accordance with TxDOT Standard Specification Item 585, "Ride Quality for Pavement Surfaces."

**205.7. BID ITEM:**

Item 205.1 - Hot Mix Asphaltic Pavement Type A - per square yard 4 inches pavement thickness

Item 205.2 - Hot Mix Asphaltic Pavement Type B - N/A

Item 205.3 - Hot Mix Asphaltic Pavement Type C - N/A

Item 205.4 - Hot Mix Asphaltic Pavement Type D - per square yard 2 inches pavement thickness

Item 205.5 - Hot Mix Asphaltic Pavement Type F - N/A

## ITEM

### 209 CONCRETE PAVEMENT

**209.1. DESCRIPTION:** *Construct hydraulic cement concrete pavement with or without curbs on the concrete pavement.*

**209.2. MATERIALS:**

**A. Hydraulic Cement Concrete.** Provide hydraulic cement concrete in accordance with Item 300, "Concrete," except that strength over-design is not required. Provide Class P concrete designed to meet a minimum average compressive strength of 3,500 psi at 7-days or a minimum average compressive strength of 4,400 psi at 28-days. Test in accordance with TxDOT standard laboratory test procedure Tex-448-A or Tex-418-A.

When shown on the plans or allowed, provide Class HES concrete for very early opening of small pavement areas or leave-outs to traffic. Design Class HES to meet the requirements of Class P and a minimum average compressive strength of 2,600 psi in 24-hours, unless other early strength and time requirements are shown on the plans or allowed. No strength over-design is required. Type III cement is allowed for Class HES concrete.

Use Class A or P concrete for curbs that are placed separately from the pavement. Provide concrete that is workable and cohesive, possesses satisfactory finishing qualities, and conforms to the mix design and mix design slump.

**B. Reinforcing Steel.** Unless shown on the plans, provide Grade 60 deformed steel for bar reinforcement in accordance with Item 301, "Reinforcing Steel." Provide approved positioning and supporting devices (baskets and chairs) capable of securing and holding the reinforcing steel in proper position before and during paving in accordance with 209.B.3, "Positioning and Support Devices for Reinforcement and Joint Assemblies." Provide corrosion protection when shown on the plans.

**1. Dowels.** Provide smooth, straight dowels of the size shown on the plans, free of burrs, and conforming to the requirements of Item 301, "Reinforcing Steel." Coat dowels with a thin film of grease or other approved de-bonding material. Provide dowel caps on the lubricated end of each dowel bar used in an expansion joint. Provide dowel caps filled with a soft compressible material with enough range of movement to allow complete closure of the expansion joint.

**2. Tie Bars.** Provide straight deformed steel tie bars. Provide either multiple-piece tie bars or single-piece tie bars as shown on the plans. Provide multiple-piece tie bars composed of 2 pieces of deformed reinforcing steel with a coupling capable of developing a minimum tensile strength of 125% of the design yield strength of the deformed steel when tensile-tested in the assembled configuration. Provide a minimum length of 33 diameters of the deformed steel in each piece. Use multiple-piece tie bars from the list of "Prequalified Multiple Piece Tie Bar Producers" maintained by the TxDOT Construction Division, or submit samples for testing in accordance with TxDOT standard laboratory test procedure Tex-711-I. A laboratory test report from an independent laboratory that has conducted Tex-711-I on the unapproved multiple piece tie bar may also be submitted to the Engineer for consideration.

- C. Positioning and Support Devices for Reinforcement and Joint Assemblies.** These devices shall be of sufficient structural quality to prevent movement of the dowels or steel reinforcement during concrete placement and finishing. Devices shall be of a type approved by the Engineer.

Positioning and supporting devices (chairs) for steel reinforcement bars shall be either plastic or metal and of sufficient number to maintain the position of the bars within the allowable tolerances.

Metal positioning and supporting devices for expansion and contraction joint assemblies (such as welded wire bar chairs, bar stakes, etc.) where used shall be as shown on the plans or may be similar devices of equivalent or greater strength, approved by the Engineer. The support devices shall secure the joint assembly and dowels within the allowable tolerances while providing no restraint against joint movement. Dowels used in joint assemblies shall be secured in parallel position by a transverse metal brace of the type and design shown on the plans, or may be secured by other devices approved by the Engineer. The devices shall provide positive mechanical connection between the brace and each unit (other than by wire tie) and prevent transverse movement of each load transmission device.

- D. Curing Materials.** Provide Type 2 membrane curing compound conforming to TxDOT DMS-4650, "Hydraulic Cement Concrete Curing Materials and Evaporation Retardants." Provide SS-1 emulsified asphalt conforming to TxDOT Item 300, "Asphalts, Oils, and Emulsions," for concrete pavement to be overlaid with asphalt concrete under this Contract unless otherwise shown on the plans or approved. Provide materials for other methods of curing conforming to the requirements of Item 307, "Concrete Structures."
- E. Epoxy.** Provide Type III epoxy in accordance with TxDOT DMS-6100, "Epoxies and Adhesives," for installing all drilled-in reinforcing steel.
- F. Evaporation Retardant.** Provide evaporation retardant conforming to TxDOT DMS-4650, "Hydraulic Cement Concrete Curing Materials and Evaporation Retardants."
- G. Joint Sealants and Fillers.** Provide Class 5 or Class 8 joint-sealant materials and fillers unless otherwise shown on the plans or approved and other sealant materials of the size, shape, and type shown on the plans in accordance with TxDOT DMS-6310, "Joint Sealants and Fillers."
- 209.3. EQUIPMENT:** Furnish and maintain all equipment in good working condition. Use measuring, mixing, and delivery equipment conforming to the requirements of Item 300, "Concrete." Obtain approval for other equipment used.
- A. Placing, Consolidating, and Finishing Equipment.** Provide approved self-propelled paving equipment that uniformly distributes the concrete with minimal segregation and provides a smooth machine-finished consolidated concrete pavement conforming to plan line and grade. Provide an approved automatic grade control system on slip-forming equipment. Provide approved mechanically operated finishing floats capable of producing a uniformly smooth pavement surface. Provide equipment capable of providing a fine, light water fog mist.

Provide mechanically operated vibratory equipment capable of adequately consolidating the concrete. Provide immersion vibrators on the paving equipment at sufficiently close intervals to provide uniform vibration and consolidation of the concrete over the entire width and depth of the pavement and in accordance with the manufacturer's recommendations. Provide

immersion vibrator units that operate at a frequency in air of at least 8,000 cycles per minute. Provide enough hand-operated immersion vibrators for timely and proper consolidation of the concrete along forms, at joints and in areas not covered by other vibratory equipment. Surface vibrators may be used to supplement equipment-mounted immersion vibrators. Provide tachometers to verify the proper operation of all vibrators.

For small or irregular areas or when approved, the paving equipment described in this Section is not required.

**B. Forming Equipment.**

1. **Pavement Forms.** Provide metal side forms of sufficient cross-section, strength, and rigidity to support the paving equipment and resist the impact and vibration of the operation without visible springing or settlement. Use forms that are free from detrimental kinks, bends, or warps that could affect ride quality or alignment. Provide flexible or curved metal or wood forms for curves of 100 foot radius or less.
2. **Curb Forms.** Provide curb forms for separately placed curbs that are not slipformed that conform to the requirements of Item 500, "Concrete Curb, Gutter, and Concrete Curb and Gutter."

**C. Reinforcing Steel Inserting Equipment.** Provide inserting equipment that accurately inserts and positions reinforcing steel in the plastic concrete parallel to the profile grade and horizontal alignment in accordance to plan details.

**D. Texturing Equipment.**

1. **Carpet Drag.** Provide a carpet drag mounted on a work bridge or a moveable support system. Provide a single piece of carpet of sufficient transverse length to span the full width of the pavement being placed and adjustable so that a sufficient longitudinal length of carpet is in contact with the concrete being placed to produce the desired texture. Obtain approval to vary the length and width of the carpet to accommodate specific applications. Use an artificial grass-type carpet having a molded polyethylene pile face with a blade length of  $\frac{5}{8}$  to 1 inch, a minimum weight of 70 oz. per square yard, and a strong, durable, rot-resistant backing material bonded to the facing.
2. **Tining Equipment.** Provide a self-propelled transverse metal tine device equipped with 4 to 6 inch steel tines and with cross-section approximately  $\frac{1}{32}$  inch thick by  $\frac{1}{12}$  inch wide, spaced at 1 inch, center-to-center. Hand-operated tining equipment that produces an equivalent texture may be used only on small or irregularly shaped areas or, when permitted, in emergencies due to equipment breakdown.

**E. Curing Equipment.** Provide a self-propelled machine for applying membrane curing compound using mechanically pressurized spraying equipment with atomizing nozzles. Provide equipment and controls that maintain the required uniform rate of application over the entire paving area. Provide curing equipment that is independent of all other equipment when required to meet the requirements of Article 209.4.I, "Curing." Hand-operated pressurized spraying equipment with atomizing nozzles may be used on small or irregular areas or when permitted.

- F. Sawing Equipment.** Provide power-driven concrete saws to saw the joints shown on the plans. Provide standby power-driven concrete saws during concrete sawing operations. Provide adequate illumination for nighttime sawing.
  - G. Grinding Equipment.** When required, provide self propelled powered grinding equipment that is specifically designed to smooth and texture concrete pavement using circular diamond blades. Provide equipment with automatic grade control capable of grinding at least a 3 foot width longitudinally in each pass without damaging the concrete.
  - H. Testing Equipment.** Provide testing equipment regardless of job-control testing responsibilities in accordance with Item 300, "Concrete," unless otherwise shown in the plans or specified.
  - I. Coring Equipment.** When required, provide coring equipment capable of extracting cores in accordance with the requirements of TxDOT standard laboratory test procedure Tex-424-A.
  - J. Miscellaneous Equipment.** Furnish both 10 foot and 15 foot steel or magnesium long-handled standard straightedges. Furnish enough work bridges, long enough to span the pavement, for finishing and inspection operations. Furnish date stencils to impress pavement placement dates into the fresh concrete, with numerals approximately 2 inches high by 1 inch wide by  $\frac{1}{4}$  inch deep.
- 209.4. CONSTRUCTION:** Obtain approval for adjustments to plan grade-line to maintain thickness over minor subgrade or base high spots while maintaining clearances and drainage. Maintain subgrade or base in a smooth, clean, compacted condition in conformity with the required section and established grade until the pavement concrete is placed. Keep subgrade or base damp with water sufficiently in advance of placing pavement concrete. Adequately light the active work areas for all nighttime operations. Provide and maintain tools and materials to perform testing.
- A. Paving and Quality Control Plan.** Unless otherwise shown on the plans, submit a paving and quality control plan for approval before beginning pavement construction operations. Include details of all operations in the concrete paving process, including longitudinal construction joint layout, sequencing, curing, lighting, early opening, leave-outs, sawing, inspection, testing, construction methods, other details and description of all equipment. List certified personnel performing the testing. Submit revisions to the paving and quality control plan for approval.
  - B. Job-Control Testing.** Unless otherwise shown on the plans, perform all fresh and hardened concrete job-control testing at the specified frequency. Provide job-control testing personnel meeting the requirements of Item 300, "Concrete." Provide and maintain testing equipment, including strength testing equipment at a location acceptable to the Engineer. Use of a commercial laboratory is acceptable. Maintain all testing equipment calibrated in accordance with pertinent test methods. Make strength-testing equipment available to the Engineer for verification testing.

Provide the Engineer the opportunity to witness all tests. The Engineer may require a retest if not given the opportunity to witness. Furnish a copy of all test results to the Engineer daily. Check the first few concrete loads for slump, air, and temperature on start-up production days to check for concrete conformance and consistency. Sample and prepare strength test specimens (2 specimens per test) on the first day of production and for each 3,000 square yards or fraction thereof of concrete pavement thereafter. Prepare at least 1 set of strength-test specimens for each production day. Perform slump, air, and temperature tests each time

strength specimens are made. Monitor concrete temperature to ensure that concrete is consistently within the temperature requirements. The Engineer will direct random job-control sampling and testing. Immediately investigate and take corrective action as approved if any Contractor test result, including tests performed for verification purposes, does not meet specification requirements.

When job-control testing by the Contractor is waived by the plans, the Engineer will perform the testing; however, this does not waive the Contractor's responsibility for providing materials and work in accordance with this Item.

- 1. Job-Control Strength.** Unless otherwise shown on the plans or permitted by the Engineer, use 7-day job-control concrete strength testing in accordance with TxDOT standard laboratory test procedure Tex-418-A.

For 7-day job-control by compressive strength, use a compressive strength of 3,200 psi or a lower job-control strength value proven to meet a 28-day compressive strength of 4,400 psi as correlated in accordance with TxDOT standard laboratory test procedure Tex-427-A.

Job control of concrete strength may be correlated to an age other than 7-days in accordance with TxDOT standard laboratory test procedure Tex-427-A when approved. Job-control strength of Class HES concrete is based on the required strength and time.

When a job-control concrete strength test value is more than 10% below the required job-control strength or when 3 consecutive job-control strength values fall below the required job-control strength, investigate the strength test procedures, the quality of materials, the concrete production operations, and other possible problem areas to determine the cause. Take necessary action to correct the problem, including redesign of the concrete mix if needed. The Engineer may suspend concrete paving if the Contractor is unable to identify, document, and correct the cause of low strength test values in a timely manner. If any job-control strength is more than 15% below the required job-control strength, the Engineer may evaluate the structural adequacy of the pavements. When directed, remove and replace pavements found to be structurally inadequate at no additional cost.

- 2. Split-Sample Verification Testing.** When indicated on the plans, perform split-sample verification testing with the Engineer on random samples taken and split by the Engineer at a rate of at least 1 for every 10 job-control samples. The Engineer will evaluate the results of split-sample verification testing. Immediately investigate and take corrective action as approved when results of split-sample verification testing differ more than the allowable differences shown in Table 1, or when the average of 10 job-control strength results and the Engineer's split-sample strength result differ by more than 10%.

**Table 1**  
**Verification Testing Limits**

<b>Test Method<sup>1</sup></b>	<b>Allowable Differences</b>
Temperature, Tex-422-A	2°F
Slump, Tex-415-A	1 inch
Air content, Tex-414-A or Tex-416-A	1%
Compressive strength, Tex-418-A	10%

<sup>1</sup> TxDOT standard laboratory test procedures

- C. Reinforcing Steel and Joint Assemblies.** Accurately place and secure in position all reinforcing steel as shown on the plans and in accordance with the requirements herein. Place dowels at mid-depth of the pavement slab, parallel to the surface. Place dowels for transverse contraction joints parallel to the pavement edge. Tolerances for location and alignment of dowels will be shown on the plans. Stagger the longitudinal reinforcement splices to avoid having more than  $\frac{1}{3}$  of the splices within a 2 foot longitudinal length of each lane of the pavement. Use multiple-piece tie bars or drill and epoxy grout tie bars at longitudinal construction joints. Verify that tie bars that are drilled and epoxied into concrete at longitudinal construction joints develop a pullout resistance equal to a minimum of  $\frac{3}{4}$  of the yield strength of the steel after 7-days. Test 15 bars using ASTM E-488, except that alternate approved equipment may be used. All 15 tested bars must meet the required pullout strength. If any of the test results do not meet the required minimum pullout strength, perform corrective measures to provide equivalent pullout resistance. Repair damage from testing. Acceptable corrective measures include but are not limited to installation of additional or longer tie bars.
- 1. Manual Placement.** Secure reinforcing bars at alternate intersections with wire ties or locking support chairs. Tie all splices with wire.
  - 2. Mechanical Placement.** If mechanical placement of reinforcement results in steel misalignment or improper location, poor concrete consolidation, or other inadequacies, complete the work using manual methods.
- D. Joints.** Install joints as shown on the plans. Joint sealants are not required on concrete pavement that is to be overlaid with asphaltic materials. Clean and seal joints in accordance with TxDOT Item 438, "Cleaning and Sealing Joints and Cracks (Rigid Pavement and Bridge Decks)." Repair excessive spalling of the joint saw groove using an approved method before installing the sealant. Seal all joints before opening the pavement to all traffic. When placing of concrete is stopped, install a rigid transverse bulkhead, accurately notched for the reinforcing steel and shaped accurately to the cross-section of the pavement.
- 1. Placing Reinforcement at Joints.** Where the plans require an assembly of parts at pavement joints, complete and place the assembly at the required location and elevation with all parts rigidly secured in the required position. Accurately notch joint materials for the reinforcing steel.
  - 2. Transverse Construction Joints.**
    - a. Jointed Concrete Pavement.** When the placing of concrete is intentionally stopped, install and rigidly secure a complete joint assembly and bulkhead in the planned transverse contraction joint location. When the placing of concrete is unintentionally

stopped, install a transverse construction joint either at a planned transverse contraction joint location or mid-slab between planned transverse contraction joints. For mid-slab construction joints, install tie bars of the size and spacing used in the longitudinal joints.

- b. Curb Joints.** Provide joints in the curb of the same type and location as the adjacent pavement. Use expansion joint material of the same thickness, type, and quality required for the pavement and of the section shown for the curb. Extend expansion joints through the curb. Construct curb joints at all transverse pavement joints. For non-monolithic curbs, place reinforcing steel into the plastic concrete pavement as shown on the plans unless otherwise approved. Form or saw the weakened plane joint across the full width of concrete pavement and through the monolithic curbs. Construct curb joints in accordance with Item 500, "Concrete Curb, Gutter, and Curb and Gutter."

- E. Placing and Removing Forms.** Use clean and oiled forms. Secure forms on a base or firm subgrade that is accurately graded and that provides stable support without deflection and movement by form riding equipment. Pin every form at least at the middle and near each end. Tightly join and key form sections together to prevent relative displacement.

Set side forms far enough in advance of concrete placement to permit inspection. Check conformity of the grade, alignment, and stability of forms immediately before placing concrete, and make all necessary corrections. Use a straightedge or other approved method to test the top of forms to ensure that the ride quality requirements for the completed pavement will be met. Stop paving operations if forms settle or deflect more than  $\frac{1}{8}$  inch under finishing operations. Reset forms to line and grade, and refinish the concrete surface to correct grade.

Avoid damage to the edge of the pavement when removing forms. Repair damage resulting from form removal and honeycombed areas with a mortar mix within 24 hours after form removal unless otherwise approved. Clean joint face and repair honeycombed or damaged areas within 24 hours after a bulkhead for a transverse construction joint has been removed unless otherwise approved. When forms are removed before 72 hours after concrete placement, promptly apply membrane curing compound to the edge of the concrete pavement.

Forms that are not the same depth as the pavement but are within 2 inches of that depth are permitted if the subbase is trenched or the full width and length of the form base is supported with a firm material to produce the required pavement thickness. Promptly repair the form trench after use. Use flexible or curved wood or metal forms for curves of 100 foot radius or less.

- F. Concrete Delivery.** Clean delivery equipment as necessary to prevent accumulation of old concrete before loading fresh concrete. Use agitated delivery equipment for concrete designed to have a slump of more than 5 inches. Segregated concrete is subject to rejection. Place agitated concrete within 60 minutes after batching. Place non-agitated concrete within 45 minutes after batching. In hot weather or under conditions causing quick setting of the concrete, times may be reduced by the Engineer. Time limitations may be extended if the Contractor can demonstrate that the concrete can be properly placed, consolidated, and finished without the use of additional water.

- G. Concrete Placement.** Do not allow the pavement edge to deviate from the established paving line by more than  $\frac{1}{2}$  inch at any point. Place the concrete as near as possible to its final location, and minimize segregation and re-handling. Where hand spreading is necessary, distribute concrete using shovels. Do not use rakes or vibrators to distribute concrete.
- 1. Pavement.** Consolidate all concrete by approved mechanical vibrators operated on the front of the paving equipment. Use immersion-type vibrators that simultaneously consolidate the full width of the placement when machine finishing. Keep vibrators from dislodging reinforcement. Use hand-operated vibrators to consolidate concrete in areas not accessible to the machine-mounted vibrators. Do not operate machine-mounted vibrators while the paving equipment is stationary. Vibrator operations are subject to review.
  - 2. Date Imprinting.** Imprint dates in the fresh concrete indicating the date of the concrete placement. Make impressions approximately 1 foot from the outside longitudinal construction joint or edge of pavement and approximately 1 foot from the transverse construction joint at the beginning of the placement day. Orient the impressions to be read from the outside shoulder in the direction of final traffic. Impress date in DD MM YY format. Imprinting of the Contractor name or logo in similar size characters to the date is allowed.
  - 3. Curbs.** Where curbs are placed separately, conform to the requirements of Item 500, "Concrete Curb, Gutter, and Curb and Gutter."
  - 4. Temperature Restrictions.** Place concrete that is between 40°F and 95°F when measured in accordance with TxDOT standard laboratory test procedure Tex-422-A at the time of discharge, except that concrete may be used if it was already in transit when the temperature was found to exceed the allowable maximum. Take immediate corrective action or cease concrete production when the concrete temperature exceeds 95°F.

Do not place concrete when the ambient temperature in the shade is below 40°F and falling unless approved. Concrete may be placed when the ambient temperature in the shade is above 35°F and rising or above 40°F. When temperatures warrant protection against freezing, protect the pavement with an approved insulating material capable of protecting the concrete for the specified curing period. Submit for approval proposed measures to protect the concrete from anticipated freezing weather for the first 72-hours after placement. Repair or replace all concrete damaged by freezing.

- H. Spreading and Finishing.** Unless otherwise shown on the plans, finish all concrete pavements with approved self-propelled equipment. Use power-driven spreaders, power-driven vibrators, power-driven strike-off, and screed, or approved alternate equipment. Use the transverse finishing equipment to compact and strike off the concrete to the required section and grade without surface voids. Use float equipment for final finishing. Use concrete with a consistency that allows completion of all finishing operations without addition of water to the surface. Use the minimal amount of water fog mist necessary to maintain a moist surface. Reduce fogging if float or straightedge operations result in excess slurry.
- 1. Finished Surface.** Perform sufficient checks with long-handled 10 foot and 15 foot straightedges on the plastic concrete to ensure that the final surface is within the tolerances specified in Surface Test A in TxDOT standard test procedure Item 585, "Ride Quality for Pavement Surfaces." Check with the straightedge parallel to the centerline.

- 2. Maintenance of Surface Moisture.** Prevent surface drying of the pavement before application of the curing system by means that may include water fogging, the use of wind screens and the use of evaporation retardants. Apply evaporation retardant at the rate recommended by the manufacturer. Reapply the evaporation retardant as needed to maintain the concrete surface in a moist condition until curing system is applied. Do not use evaporation retardant as a finishing aid. Failure to take acceptable precautions to prevent surface drying of the pavement will be cause for shut down of pavement operations.
- 3. Surface Texturing.** Complete final texturing before the concrete has attained its initial set. Drag the carpet longitudinally along the pavement surface with the carpet contact surface area adjusted to provide a satisfactory coarsely textured surface. Prevent the carpet from getting plugged with grout. Do not perform carpet dragging operations while there is excessive bleed water.

A metal-tine texture finish is required for all areas with a posted speed limit in excess of 45 mph. A metal-tine texture finish is required unless otherwise shown on the plans for areas with a posted speed limit less than 45 mph. Immediately following the carpet drag, apply a single coat of evaporation retardant at a rate recommended by the manufacturer. Provide the metal-tine finish immediately after the concrete surface has set enough for consistent tining. Operate the metal-tine device to obtain grooves spaced at 1 inch, approximately 3/16 inch deep, with a minimum depth of 1/8 inch, and approximately 1/12 inch wide. Do not overlap a previously tined area. Use manual methods to achieve similar results on ramps and other irregular sections of pavements. Repair damage to the edge of the slab and joints immediately after texturing. Do not tine pavement that will be overlaid or that is scheduled for blanket diamond grinding or shot blasting.

When carpet drag is the only surface texture required by the plans, ensure that adequate and consistent micro-texture is achieved by applying sufficient weight to the carpet and keeping the carpet from getting plugged with grout, as directed by the Engineer. Target a carpet drag texture of .04 inch, as measured by Tex-436-A Correct any location with a texture less than .03 inch by diamond grinding or shot blasting. The Engineer will determine the test locations at points located transversely to the direction of traffic in the outside wheel path.
- 4. Small or Irregular Placements.** Where machine placements and finishing of concrete pavement are not practical, use hand equipment and procedures that produce a consolidated and finished pavement section to the line and grade.
- 5. Emergency Procedures.** Use hand-operated equipment for applying texture, evaporation retardant, and cure in the event of equipment breakdown.
- I. Curing.** Keep the concrete pavement surface from drying as described in Section 209.4.H.2, "Maintenance of Surface Moisture," until the curing material has been applied. Maintain and promptly repair damage to curing materials on exposed surfaces of concrete pavement continuously for at least 3 curing days. A curing day is defined as a 24 hour period when either the temperature taken in the shade away from artificial heat is above 50°F for at least 19 hours or when the surface temperature of the concrete is maintained above 40°F for 24 hours. Curing begins when the concrete curing system has been applied. Stop concrete paving if curing compound is not being applied promptly and maintained adequately. Other methods of curing in accordance with Item 307, "Concrete Structures," may be used when specified or approved.

- 1. Membrane Curing.** Spray the concrete surface uniformly with 2 coats of membrane curing compound at an individual application rate of not more than 180 square feet per gallon. Do not allow the concrete surface to dry before applying the curing compound. Use a towel or absorptive fabric to remove any standing pools of bleed water that may be present on the surface before applying the curing compound. Apply the first coat within 10 min. after completing texturing operations. Apply the second coat within 30 minutes after completing texturing operations.

Before and during application, maintain curing compounds in a uniformly agitated condition, free of settlement. Do not thin or dilute the curing compound.

Where the coating shows discontinuities or other defects or if rain falls on the newly coated surface before the film has dried enough to resist damage, apply additional compound at the same rate of coverage to correct the damage. Ensure that the curing compound coats the sides of the tining grooves.

- 2. Asphalt Curing.** When an asphaltic concrete overlay is required, apply a uniform coating of asphalt curing at a rate of 90 to 180 square feet per gallon as required. Apply curing immediately after texturing and just after the free moisture (sheen) has disappeared. Obtain approval to add water to the emulsion to improve spray distribution. Maintain the asphalt application rate when using diluted emulsions. Maintain the emulsion in a mixed condition during application.
  - 3. Curing Class HES Concrete.** For all Class HES concrete pavement, provide membrane curing in accordance with Section 209.4.I.1, "Membrane Curing," followed promptly by water curing until opening strength is achieved but not less than 24 hours.
- J. Sawing Joints.** Saw joints to the depth shown on the plans as soon as sawing can be accomplished without damage to the pavement regardless of time of day or weather conditions. Some minor raveling of the saw cut is acceptable. Use a chalk line, string line, sawing template, or other approved method to provide a true joint alignment. Provide enough saws to match the paving production rate to ensure sawing completion at the earliest possible time to avoid uncontrolled cracking. Reduce paving production if necessary to ensure timely sawing of joints. Promptly restore membrane cure damaged within the first 72 hours of curing.
- K. Protection of Pavement and Opening to Traffic.** Testing for early opening is the responsibility of the Contractor regardless of job-control testing responsibilities unless otherwise shown in the plans or directed. Testing result interpretation for opening to traffic is subject to the approval of the Engineer.
- 1. Protection of Pavement.** Erect and maintain barricades and other standard and approved devices that will exclude all vehicles and equipment from the newly placed pavement for the periods specified. Before opening to traffic, protect the pavement from damage due to crossings using approved methods. Where a detour is not readily available or economically feasible, an occasional crossing of the roadway with overweight equipment may be permitted for relocating equipment only but not for hauling material. When an occasional crossing of overweight equipment is permitted, temporary matting or other approved methods may be required.

Maintain an adequate supply of sheeting or other material to cover and protect fresh concrete surface from weather damage. Apply as needed to protect the pavement surface from weather.

2. **Opening Pavement to All Traffic.** Pavement that is 7 days old may be opened to all traffic. Before opening to traffic, clean pavement, place stable material against the pavement edges, seal joints, and perform all other traffic safety related work.
3. **Opening Pavement to Construction Equipment.** Unless otherwise shown on the plans, concrete pavement may be opened early to concrete paving equipment and related delivery equipment after the concrete is at least 48 hours old and opening strength has been demonstrated in accordance with Section 209.4.K.4, "Early Opening to All Traffic," before curing is complete. Keep delivery equipment at least 2-feet from the edge of the concrete pavement. Keep tracks of the paving equipment at least 1 foot from the pavement edge. Protect textured surfaces from the paving equipment. Restore damaged membrane curing as soon as possible. Repair pavement damaged by paving or delivery equipment before opening to all traffic.
4. **Early Opening to All Traffic.** Concrete pavement may be opened after curing is complete and the concrete has attained a compressive strength of 2,800 psi, except that pavement using Class HES concrete may be opened after 24 hours if the specified strength is achieved.
  - a. **Strength Testing.** Test concrete specimens cured under the same conditions as the portion of the pavement involved.
  - b. **Maturity Method.** Unless otherwise shown on the plans, the maturity method, TxDOT standard laboratory test procedure Tex-426-A, may be used to estimate concrete strength for early opening pavement to traffic. Install at least 2 maturity thermocouples for each day's placement in areas where the maturity method will be used for early opening. Thermocouples, when used, will be installed near the day's final placement for areas being evaluated for early opening. Use test specimens to verify the strength-maturity relationship in accordance with TxDOT standard laboratory test procedure Tex-426-A, starting with the first day's placement corresponding to the early opening pavement section.

After the first day, verify the strength-maturity relationship at least every 10 days of production. Establish a new strength-maturity relationship when the strength specimens deviate more than 10% from the maturity-estimated strengths. Suspend use of the maturity method for opening pavements to traffic when the strength-maturity relationship deviates by more than 10% until a new strength-maturity relationship is established.

When the maturity method is used intermittently or for only specific areas, the frequency of verification will be as determined by the Engineer.

5. **Emergency Opening to Traffic.** Under emergency conditions, when the pavement is at least 72 hours old, open the pavement to traffic when directed in writing. Remove all obstructing materials, place stable material against the pavement edges, and perform other work involved in providing for the safety of traffic as required for emergency opening.

**L. Pavement Thickness.** Unless otherwise shown on the plans, the Engineer will perform 1 thickness test consisting of 1 reading at approximately the center of each lane every 500 feet or fraction thereof. The Engineer will check the thickness in accordance with TxDOT standard laboratory test procedure Tex-423-A unless other methods are shown on the plans. Core where directed in accordance with TxDOT standard laboratory test procedure Tex-424-A to verify deficiencies of more than 0.2 inch from plan thickness and to determine the limits of deficiencies of more than 0.75 inch from plan thickness. Fill core holes using a concrete mixture and method approved by the Engineer.

- 1. Thickness Deficiencies Greater than 0.2-inch.** When any depth test measured in accordance with TxDOT standard laboratory test procedure Tex-423-A is deficient by more than 0.2 inch from the plan thickness, take one 4-inch diameter core at that location to verify the measurement.

If the core is deficient by more than 0.2 inch but not by more than 0.75 inch from the plan thickness, take 2 additional cores from the unit (as defined in Section 209.4.L.3, "Pavement Units for Payment Adjustment") at intervals of at least 150 feet and at locations selected by the Engineer, and determine the thickness of the unit for payment purposes by averaging the length of the 3 cores. In calculations of the average thickness of this unit of pavement, measurements in excess of the specified thickness by more than 0.2 inch will be considered as the specified thickness plus 0.2 inch.

- 2. Thickness Deficiencies Greater than 0.75-inch.** If a core is deficient by more than 0.75 inch, take additional cores at 10 foot intervals in each direction parallel to the centerline to determine the boundary of the deficient area. The Engineer will evaluate any area of pavement found deficient in thickness by more than 0.75 inch but not more than 1 inch. As directed, remove and replace the deficient areas without additional compensation or retain deficient areas without compensation. Remove and replace any area of pavement found deficient in thickness by more than 1 inch without additional compensation.
- 3. Pavement Units for Payment Adjustment.** Limits for applying a payment adjustment for deficient pavement thickness from 0.2 inch to not more than 0.75 inch are 500-feet of pavement in each lane. Lane width will be as shown on typical sections and pavement design standards.

For greater than 0.75 inch deficient thickness, the limits for applying zero payment or requiring removal will be defined by coring or equivalent nondestructive means as determined by the Engineer. The remaining portion of the unit determined to be less than 0.75 inch deficient will be subject to the payment adjustment based on the average core thickness at each end of the 10 foot interval investigation as determined by the Engineer.

Shoulders will be measured for thickness unless otherwise shown on the plans. Shoulders 6 feet wide or wider will be considered as lanes. Shoulders less than 6 feet wide will be considered part of the adjacent lane.

Limits for applying payment adjustment for deficient pavement thickness for ramps, widenings, acceleration and deceleration lanes, and other miscellaneous areas are 500 feet in length. Areas less than 500 feet in length will be individually evaluated for payment adjustment based on the plan area.

**M. Ride Quality.** When required by the plans, measure ride quality in accordance with TxDOT Item 585, "Ride Quality for Pavement Surfaces." Surface Test Type A or B as well as Pay Schedule 1, 2, or 3 shall also be indicated on the plans.

**209.5. MEASUREMENT:** This Item will be measured as follows:

- A. Concrete Pavement.** Concrete pavement will be measured by the square yard of surface area in place. The surface area includes the portion of the pavement slab extending beneath the curb.
- B. Curb.** Curb on concrete pavement will be measured by the foot in place.

**209.6. PAYMENT:** Payment includes full compensation for materials, equipment, labor, tools, and incidentals.

- A. Concrete Pavement.** The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the adjusted unit price bid for "Concrete Pavement" of the type and depth specified as adjusted in accordance with Sections 209.6.B, "Deficient Thickness Adjustment" and 209.4.M, "Ride Quality."
- B. Deficient Thickness Adjustment.** Where the average thickness of pavement is deficient in thickness by more than 0.2 inch but not more than 0.75 inch, payment will be made using the adjustment factor as specified in Table 2 applied to the bid price for the deficient area for each unit as defined under Section 209.4.L.3, "Pavement Units for Payment Adjustment."

**Table 2**  
**Deficient Thickness Price Adjustment Factor (1 in = 25.4 mm)**

Deficiency in Thickness Determined by Cores (in.)	Proportional Part of Contract Price Allowed (adjustment factor)
Not deficient	1.00
Over 0.00 through 0.20	1.00
Over 0.20 through 0.30	0.80
Over 0.30 through 0.40	0.72
Over 0.40 through 0.50	0.68
Over 0.50 through 0.75	0.57

- C. Curb.** Work performed and furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Curb" of the type specified.

**209.7. BID ITEM:**

N/A

## ITEM

### 210 ROLLING

**210.1. DESCRIPTION:** Compact embankment, subgrade, base, surface treatments, broken concrete pavement, or asphalt pavement using rollers. Break up asphalt mats, pit run material, or base materials.

**210.2. EQUIPMENT:** The Contractor may use any type of roller to meet the production rates and quality requirements of the Contract unless otherwise shown on the plans or directed. When specific types of equipment are required, use equipment that meets the requirements of this Article. The Engineer may allow the use of rollers that operate in one direction only when turning does not affect the quality of work or encroach on traffic.

**Table 1**  
**Roller Requirements<sup>1</sup>**

Roller Type	Materials to be Compacted	Load (tons)	Contact Pressure	Roller Speed (mph)
Steel wheel	Embankment, subgrade, base, asphalt concrete	≥ 10	≥ 325 lb. per linear inch of wheel width	2–3
Tamping	Embankment, subgrade, base	–	125–550 psi per tamping foot	2–3
Heavy tamping	Embankment, subgrade, base	–	≤ 550 psi per tamping foot	2–3
Vibratory	Embankment, subgrade, base, asphalt concrete	Type A < 6 Type B > 6 Type C as shown on plans	Per equipment specification and as approved	As approved
Light pneumatic	Embankment, subgrade, base, surface treatment	4.5–9.0	≥ 45 psi	2–6
	Asphalt Concrete			4–12
Medium pneumatic	Same as light pneumatic	12–25	≥ 80 psi, as directed	Same as light pneumatic
Heavy pneumatic	Embankment, subgrade, base, previously broken concrete pavement, other pavements	≥ 25	≤ 150 psi	2–6
Grid	Embankment, base, breaking up existing asphalt mats or base	5–13	–	2–3

1. Unless otherwise specified in the Contract.

1 ton = 0.9 megagrams; 1 psi = 6.9 kPa, 1 lb = 0.45 kg, 1 in = 25.4 mm, 1 mph = 1 kph

**A. Static Steel Wheel Rollers.** Furnish single, double, or triple steel wheel, self-propelled power rollers weighing at least 10 tons capable of operating in a forward and backward

motion. Confirm all wheels are flat. When static steel wheel rollers are required, vibratory rollers in the static mode may be used.

For single steel wheel rollers, pneumatic rear wheels are allowed for embankment, subgrade, and base. For triple steel wheel rollers, provide rear wheels with a minimum diameter of 48 inches, a minimum width of 20 inches, and a minimum compression of 325 pounds per inch of wheel width.

**B. Tamping Rollers.** Furnish self-propelled rollers with at least 1 self-cleaning metal tamping drum capable of operating in a forward or backward motion with a minimum effective rolling width of 5 feet. For rollers with more than 1 drum, mount drums in a frame so that each drum moves independently of the other. Operate rollers in static or vibratory mode.

**1. Tamping Roller (Minimum Requirement).** For all tamping rollers except for heavy tamping rollers, provide tamping feet that exert a static load of 125 to 550 psi and extend outward at least 3 inches from the surface of the drum.

**2. Heavy Tamping Roller.** Provide tamping rollers that have:

- 2 metal tamping drums, rolls, or shells, each with a 60 inch minimum diameter and a 5 foot minimum width, or
- 1 rear and 2 forward drums, each with a 60 inch minimum diameter. Arrange drums so that the rear drum compacts the space between the 2 forward drums and the minimum overall rolling width is 10 feet.

Equip drums with tamping feet that:

- extend outward at least 7 inches from the drum surface,
- have an area of 7 to 21 square inches,
- are self-cleaning,
- exert a static load of at least 550 psi, and
- are spaced at 1 tamping foot per 0.65 to 0.70 square feet of drum area.

**C. Vibratory Rollers.** Furnish self-propelled rollers with at least 1 drum equipped to vibrate. Select and maintain amplitude and frequency settings per manufacturer's specifications to deliver maximum compaction without material displacement or shoving, as approved. Furnish the equipment manufacturer's specifications concerning settings and controls for amplitude and frequency. Operate rollers at speeds that will produce at least 10 blows per foot unless otherwise shown on the plans or approved. Pneumatic rear wheels are allowed for embankment, subgrade, and base. Equip each vibrating drum with:

- separate frequency and amplitude controls,
- controls to manually start and stop vibration, and
- a mechanism to continuously clean the face of the drum.

For asphalt-stabilized base and asphalt concrete pavement, furnish a roller that also has the ability to:

- automatically reverse the direction of the rotating eccentric weight,
  - stop vibration before the motion of the roller stops, and
  - thoroughly moisten the drum with water or approved asphalt release agent.
1. **Drum (Type A).** Furnish a roller with a static weight less than 6 tons and a vibratory drum.
  2. **Drum (Type B).** Furnish a roller with a minimum static weight of 6 tons and a vibratory drum.
  3. **Drum (Type C).** Furnish a roller as shown on plans.

**D. Pneumatic Tire Rollers.** Pneumatic tire rollers consist of rubber tire wheels on axles mounted in a frame with either a loading platform or body suitable for ballast loading. Arrange the rear tires to cover the gaps between adjacent tires of the forward group. Furnish rollers capable of forward and backward motion. Compact asphalt pavements and surface treatments with a roller equipped with smooth-tread tires. Compact without damaging the surface. When necessary, moisten the wheels with water or an approved asphalt release agent.

Select and maintain the operating load and tire air pressure within the range of the manufacturer's charts or tabulations to attain maximum compaction throughout the lift, as approved. Furnish the manufacturer's chart or tabulations showing the contact areas and contact pressures for the full range of tire inflation pressures and for the full range of loadings for the particular tires furnished. Maintain individual tire inflation pressures within 5 psi of each other. Provide uniform compression under all tires.

1. **Light Pneumatic Tire.** Furnish a unit:

- with at least 9 pneumatic tires,
- with an effective rolling width of approximately 5 feet,
- capable of providing a total uniform load of 4.5 to 9 tons, and
- with tires capable of maintaining a minimum ground contact pressure of 45 psi.

2. **Medium Pneumatic Tire.** Furnish a unit:

- with at least 7 pneumatic tires,
- with an effective rolling width of approximately 7 feet,
- capable of providing a total uniform load of 12 to 25 tons, and
- with tires capable of maintaining a minimum ground contact pressure of 80 psi or 90 psi as directed.

**3. Heavy Pneumatic Tire.** Furnish a unit:

- with at least 4 pneumatic-tired wheels mounted on axles carrying at most 2 wheels,
- with wheels arranged to carry approximately equal loads on uneven surfaces,
- with a width between 8 and 10 feet that can turn 180° in the crown width,
- capable of providing a total uniform load of at least 25 tons,
- with tires capable of maintaining a maximum ground contact pressure of 150 psi, and
- with liquid-filled tires inflated to such a level that liquid will flow from the valve stem when the stem is in the uppermost position.

**E. Grid Rollers.** Furnish rollers that have 2 cylindrical cages with a minimum diameter of 66-inches and a minimum width of 32 inches. Mount cages in a rigid frame with weight boxes. Use a cage surface of cast or welded steel fabric grid with bars 1-½ inches wide, spaced on 5 inch centers in each direction, that undulate approximately 1-inch between the high and low points.

Furnish rollers capable of providing a total load of 5 to 13 tons and capable of being operated in a forward or backward motion

**F. Alternate Equipment.** Instead of the specified equipment, the Contractor may, as approved, operate other compaction equipment that produces equivalent results. Discontinue the use of the alternate equipment and furnish the specified equipment if the desired results are not achieved.

**210.2. CONSTRUCTION:** Perform this work in accordance with the applicable Items using equipment and roller speeds specified in Table 1. Use only rubber-tired equipment to push or pull compaction equipment on base courses. Use equipment that does not damage material being rolled.

**210.3. MEASUREMENT:** The work performed, materials furnished, equipment, labor, tools, and incidentals will not be measured directly but will be subsidiary to pertinent Items.

**210.4. PAYMENT:** The work performed, materials furnished, equipment, labor, tools, and incidentals will not be paid for directly but will be subsidiary to pertinent Items.

**210.5. BID ITEM:**

N/A

## DIVISION III - CONCRETE & CONCRETE STRUCTURES

### ITEM

### 300 CONCRETE

**300.1. DESCRIPTION:** *Furnish hydraulic cement concrete for concrete pavements, concrete structures, and other concrete construction.*

**300.2. MATERIALS:**

**A. Cement.** Furnish cement conforming to TxDOT's DMS-4600, "Hydraulic Cement."

**B. Supplementary Cementing Materials (SCM).**

1. **Fly Ash.** Furnish fly ash conforming to TxDOT's DMS-4610, "Fly Ash."

2. **Ultra-Fine Fly Ash (UFFA).** Furnish UFFA conforming to TxDOT's DMS-4610, "Fly Ash."

3. **Ground Granulated Blast-Furnace Slag (GGBFS).** Furnish GGBFS conforming to TxDOT's DMS-4620, "Ground Granulated Blast-Furnace Slag," Grade 100 or 120.

4. **Silica Fume.** Furnish silica fume conforming to TxDOT's DMS-4630, "Silica Fume."

5. **Metakaolin.** Furnish metakaolin conforming to TxDOT's DMS-4635, "Metakaolin."

**C. Chemical Admixtures.** Furnish admixtures conforming to TxDOT's DMS-4640, "Chemical Admixtures for Concrete." Do not use calcium chloride.

**D. Water.** Furnish mixing and curing water that is free from oils, acids, organic matter, or other deleterious substances. Water from municipal supplies approved by the Texas Department of Health will not require testing. When using water from other sources, provide test reports showing compliance with Table 1 before use.

Water that is a blend of concrete wash water and other acceptable water sources, certified by the concrete producer as complying with the requirements of both Table 1 and Table 2, may be used as mix water. Test the blended water weekly for 4 weeks for compliance with Table 1 and Table 2 or provide previous test results. Then test every month for compliance. Provide water test results upon request.

**Table 1  
Chemical Limits for Mix Water**

Contaminant	Test Method	Maximum Concentration (ppm)
Chloride (Cl)	ASTM C 114	500
Prestressed concrete		
Bridge decks and superstructure		
All other concrete		1,000
Sulfate (SO <sub>4</sub> )	ASTM C 114	2,000
Alkalies (N <sub>A2</sub> O + 0.658K <sub>2</sub> O)	ASTM C 114	600
Total Solids	ASTM C 1603	50,000

**Table 2**  
**Acceptance Criteria for Questionable Water Supplies**

<b>Property</b>	<b>Test Method</b>	<b>Limits</b>
Compressive strength, min. % control at 7 days	ASTM C 31, ASTM C 39 <sup>1,2</sup>	90
Time of set, deviation from control, h:min.	ASTM C 403 <sup>1</sup>	From 1:00 early to 1:30 later

<sup>1</sup>. Base comparisons on fixed proportions and the same volume of test water compared to the control mix using 100% potable water or distilled water.

<sup>2</sup>. Base comparisons on sets consisting of at least two standard specimens made from a composite sample.

Do not use mix water that has an adverse effect on the air-entraining agent, on any other chemical admixture, or on strength or time of set of the concrete. When using white hydraulic cement, use mixing and curing water free of iron and other impurities that may cause staining or discoloration.

**E. Aggregate.** Supply aggregates that meet the definitions in TxDOT standard laboratory test procedure Tex-100-E. Provide coarse and fine aggregates from sources listed in TxDOT's Concrete Rated Source Quality Catalog (CRSQC). Provide aggregate from non-listed sources only when tested and approved by the Engineer before use. Allow 30 calendar days for the Engineer to sample, test, and report results for non-listed sources. Do not combine approved material with unapproved material.

**1. Coarse Aggregate.** Provide coarse aggregate consisting of durable particles of gravel, crushed blast furnace slag, recycled crushed hydraulic cement concrete, crushed stone, or combinations thereof that are free from frozen material and from injurious amounts of salt, alkali, vegetable matter, or other objectionable material, either free or as an adherent coating. Provide coarse aggregate of uniform quality throughout.

Provide coarse aggregate that, when tested in accordance with TxDOT standard laboratory test procedure Tex-413-A, has:

- at most 0.25% by weight of clay lumps,
- at most 1.0% by weight of shale, and
- at most 5.0% by weight of laminated and friable particles.

Wear must not be more than 40% when tested in accordance with TxDOT standard laboratory test procedure Tex-410-A.

Unless otherwise shown on the plans, provide coarse aggregate with a 5 cycle magnesium sulfate soundness of not more than 18% when tested in accordance with TxDOT standard laboratory test procedure Tex-411-A. Crushed recycled hydraulic cement concrete is not subject to the 5 cycle soundness test.

The loss by decantation as tested in accordance with TxDOT standard laboratory test procedure Tex-406-A, plus the allowable weight of clay lumps, must not exceed 1.0% or the value shown on the plans, whichever is smaller. In the case of aggregates made primarily from crushing stone, if the material finer than the No. 200 sieve is established to be the dust of fracture and essentially free from clay or shale as established by TxDOT

standard laboratory test procedure Tex-406-A, Part III, the limit may be increased to 1.5%. When crushed limestone coarse aggregate is used in concrete pavements, the decant may exceed 1.0% but not more than 3.0% if the material finer than the No. 200 sieve is determined to be at least 67% calcium carbonate in accordance with TxDOT standard laboratory test procedure Tex-406-A, Part III.

Unless otherwise specified, provide aggregate conforming to the gradation requirements shown in Table 3 when tested in accordance with TxDOT standard laboratory test procedure Tex-401-A.

**Table 3**  
**Coarse Aggregate Gradation Chart**

Aggregate Grade No. <sup>1</sup>	Nominal Size	Percent Passing on Each Sieve								
		2-1/2"	2"	1-1/2"	1"	3/4"	1/2"	3/8"	No. 4	No. 8
1	2"	100	80-100	50-85		20-40			0-5	
2 (467)	1-1/2"		100	95-100		35-70		10-30	0-5	
3	1-1/2"		100	95-100		60-90	25-60		0-5	
4 (57)	1"			100	95-100		25-60		0-10	0-5
5 (67)	3/4"				100	90-100		20-55	0-10	0-5
6 (7)	1/2"					100	90-100	40-70	0-15	0-5
7	3/8"						100	70-95	0-25	
8	3/8"						100	95-100	20-65	0-10

1. Corresponding ASTM C 33 gradation shown in parentheses.

- Fine Aggregate.** Provide fine aggregate consisting of clean, hard, durable particles of natural or manufactured sand or a combination thereof with or without mineral filler. Provide fine aggregate free from frozen material and from injurious amounts of salt, alkali, vegetable matter, or other objectionable material, and containing no more than 0.5% clay lumps by weight in accordance with TxDOT standard laboratory test procedure Tex-413-A.

Provide fine aggregate that does not show a color darker than standard when subjected to the color test for organic impurities in accordance with TxDOT standard laboratory test procedure Tex-408-A.

Unless otherwise shown on the plans, use fine aggregate with an acid insoluble residue of at least 60% by weight when tested in accordance with TxDOT standard laboratory test procedure Tex-612-J in all concrete subject to direct traffic.

Unless otherwise shown on the plans, when necessary, blend the fine aggregate to meet the acid insoluble residue requirement. When blending, use the following equation:

$$\text{Acid insoluble (\%)} = \{(A1)(P1)+(A2)(P2)\}/100$$

where:

A1 = acid insoluble (%) of aggregate 1

A2 = acid insoluble (%) of aggregate 2

P1 = percent by weight of aggregate 1 of the fine aggregate blend

P2 = percent by weight of aggregate 2 of the fine aggregate blend

Provide fine aggregate or combinations of aggregates, including mineral filler, conforming to the gradation requirements shown in Table 4 when tested in accordance with TxDOT standard laboratory test procedure Tex-401-A unless otherwise specified.

**Table 4**  
**Fine Aggregate Gradation Chart (Grade 1)**

Sieve Size	Percent Passing
3/8 in.	100
No. 4	95–100
No. 8	80–100
No. 16	50–85
No. 30	25–65
No. 50	10–35 <sup>1</sup>
No. 100	0–10
No. 200	0–3 <sup>2</sup>

1. 6–35 when sand equivalent value is greater than 85.

2. 0–6 for manufactured sand.

Unless otherwise shown on the plans, provide fine aggregate with a sand equivalent of at least 80 in accordance with TxDOT standard laboratory test procedure Tex-203-F.

For all classes of concrete, provide fine aggregate with a fineness modulus between 2.30 and 3.10 as determined by TxDOT standard laboratory test procedure Tex-402-A.

- 3. Mineral Filler.** Provide mineral filler consisting of stone dust, clean crushed sand, or other approved inert material with 100% passing the No. 30 sieve and 65 to 100% passing the No. 200 sieve when tested in accordance with TxDOT standard laboratory test procedure Tex-401-A.
- F. Mortar and Grout.** When required or shown on the plans, provide mortar and grout consisting of 1 part hydraulic cement, 2 parts sand, and sufficient water to provide the desired consistency. Provide mortar with a consistency such that the mortar can be easily handled and spread by trowel. Provide grout of a consistency that will flow into and completely fill all voids. Section 300.4.A.6, “Mix Design Options,” does not apply for mortar and grout.

### 300.3. EQUIPMENT:

- A. Concrete Plants and Mixing Equipment.** Except for volumetric mixers (auger/mixer), each plant and truck mixer must be currently certified by the National Ready Mixed Concrete Association (NRMCA) or have an inspection report signed and sealed by a licensed professional engineer showing that concrete measuring, mixing, and delivery equipment meets all requirements of ASTM C-94. A new certification or signed and sealed report is required every time a plant is moved. Plants with a licensed engineer’s inspection require reinspection every 2-years. Provide a copy of the certification or the signed and sealed inspection report to the Engineer. When equipment or facilities fail to meet specification requirements, remove them from service until corrected. When allowed by the plans or the Engineer, for concrete classes not identified as structural concrete in Table 5 or for Class “C” concrete not used for bridge-class structures, the Engineer may inspect and approve all plants and trucks in lieu of the NRMCA or non-City engineer sealed certifications. The criteria and frequency of Engineer approval of plants and trucks is the same used for NRMCA certification.

1. **Scales.** Check all scales prior to beginning of operations, after each move, or whenever their accuracy or adequacy is questioned, and at least once every 6 months. Immediately correct deficiencies, and recalibrate. Provide a record of calibration showing scales in compliance with ASTM C-94 requirements. Check batching accuracy of volumetric water batching devices and admixture dispensing devices at least every 90 days. Perform daily checks as necessary to confirm measuring accuracy.
2. **Volumetric Mixers.** Provide volumetric mixers with rating plates defining the capacity and the performance of the mixer in accordance with the Volumetric Mixer Manufacturers Bureau or equivalent. Provide volumetric mixers that comply with ASTM C-685. Provide test data showing mixers meet the uniformity test requirements of TxDOT standard laboratory test procedure Tex-472-A. Unless allowed by the plans or the Engineer, volumetric mixers may not supply classes of concrete identified as structural concrete in Table 5.
3. **Agitators and Truck and Stationary Mixers.** Inspect and furnish inspection reports on truck mixers and agitators annually. If an inspection within 12 months is not practical, a 2 month grace period (for a maximum of 14 months between inspections) is permitted. Include in the report the condition of blades and fins and their percent wear from the original manufacturer's design. Repair mixing equipment exhibiting 10% or more wear before use. Provide truck mixers and agitators equipped with means to readily verify the number of revolutions of the drum, blades, or paddles.

Provide stationary and truck mixers capable of combining the ingredients of the concrete within the specified time or the number of revolutions specified into a thoroughly mixed and uniform mass and capable of discharging the concrete so that at least 5 of the 6 requirements of TxDOT standard laboratory test procedure Tex-472-A are met.

As directed, to resolve issues of mix uniformity and mixer performance, perform concrete uniformity tests on mixers or agitators in accordance with TxDOT standard laboratory test procedure Tex-472-A.

Perform the mixer or agitator uniformity test at the full rated capacity of the equipment and within the maximum mixing time or maximum number of revolutions. Remove from service all equipment that fails the uniformity test.

Inspect and maintain mixers and agitators. Keep them reasonably free of concrete buildup, and repair or replace worn or damaged blades or fins.

Confirm all mixers have a plate affixed showing manufacturer's recommended operating speed and rated capacity for mixing and agitating.

Previous inspections performed for TxDOT are acceptable for submittal provided the inspection meets the 12-month inspection period referenced above.

- B. **Hauling Equipment.** Provide hauling equipment capable of maintaining the mixed concrete in a thoroughly mixed and uniform mass and of discharging the concrete with a satisfactory degree of uniformity.

When using non-agitating equipment for transporting concrete, provide equipment with smooth, mortar-tight metal containers equipped with gates that prevent accidental discharge of the concrete.

**C. Testing Equipment.** Unless otherwise shown on the plans or specified, in accordance with the pertinent test procedure, furnish and maintain:

- test molds,
- curing facilities,
- maturity meters if used, and
- wheelbarrow or other container acceptable for the sampling of the concrete.

Provide strength-testing equipment in accordance with the Contract controlling test unless shown otherwise.

### **300.4. CONSTRUCTION:**

**A. Classification and Mix Design.** Furnish mix designs using ACI 211, “Standard Practice for Selecting Proportions for Normal, Heavy Weight, and Mass Concrete,” or other approved procedures for the classes of concrete required in accordance with Table 5. Do not exceed the maximum water-to-cementitious-material ratio. Perform mix design and cement replacement using the design by weight method unless otherwise approved.

A higher-strength class of concrete with equal or lower water-to-cementitious-material ratio may be substituted for the specified class of concrete.

To account for production variability and confirm minimum compressive strength requirements are met, over-design the mix in accordance with Table 6.

**1. Cementitious Materials.** Use cementitious materials from TxDOT prequalified sources; otherwise, request sampling and testing for approval before use. Unless otherwise specified or approved, limit cementitious material content to no more than 700 pounds per cubic yard. When supplementary cementing materials are used, “cement” is defined as “cement plus supplementary cementing material.”

Use Type III cement only in precast concrete or when specified or permitted.

For monolithic placements, use cement of the same type and from the same source.

When sulfate-resistant concrete is required, use mix design options 1, 2, 3, or 4 given in Section 300.4.A.6, “Mix Design Options,” using Type I/II, II, V, IP, or IS cement. Do not use Class C fly ash in sulfate-resistant concrete.

Do not use supplementary cementing materials when white hydraulic cement is specified.

The upper limit of 35% replacement of cement with Class F fly ash specified by mix design options 1 and 3 may be increased to a maximum of 45% for mass placements, high performance concrete, and precast members when approved.

**Table 5**  
**Concrete Classes**

<b>Class of Concrete</b>	<b>Design Strength, Min. 28-day <math>f'_c</math> (psi)</b>	<b>Maximum W/C Ratio<sup>1</sup></b>	<b>Coarse Aggregate Grades<sup>2,3</sup></b>	<b>General Usage<sup>4</sup></b>
A	3,000	0.60	1–4, 8	Inlets, manholes, curb, gutter, curb & gutter, conc. retards, sidewalks, driveways, backup walls, anchors
B	2,000	0.60	2–7	Riprap, small roadside signs, and anchors
C <sup>5</sup>	3,600	0.45	1–6	Drilled shafts, bridge substructure, bridge railing, culverts except top slab of direct traffic culverts, headwalls, wing walls, approach slabs, concrete traffic barrier (cast-in-place)
C(HPC) <sup>5</sup>	3,600	0.45	1-6	As shown on the plans
D	1,500	0.60	2–7	Riprap
E	3,000	0.50	2–5	Seal concrete
F <sup>5</sup>	Note 6	0.45	2–5	Railroad structures; occasionally for bridge piers, columns, or bents
F(HPC) <sup>5</sup>	Note 6	0.45	2–5	As shown on the plans
H <sup>5</sup>	Note 6	0.45	3–6	Prestressed concrete beams, boxes, piling, and concrete traffic barrier (precast)
H(HPC) <sup>5</sup>	Note 6	0.45	3–6	As shown on the plans
S <sup>5</sup>	4,000	0.45	2–5	Bridge slabs, top slabs of direct traffic culverts
S(HPC) <sup>5</sup>	4,000	0.45	2-5	As shown on the plans
P	See Item 209	0.45	2–3	Concrete pavement, bus pads
DC <sup>5</sup>	5,500	0.40	6	Dense conc. overlay
CO <sup>5</sup>	4,600	0.40	6	Conc. overlay
LMC <sup>5</sup>	4,000	0.40	6–8	Latex-modified concrete overlay
SS <sup>5</sup>	3,600 <sup>7</sup>	0.45	4–6	Slurry displacement shafts, underwater drilled shafts
K <sup>5</sup>	Note 6	0.45	Note 6	Note 6
HES	Note 6	0.45	Note 6	Note 6

<sup>1</sup> Maximum water-cement or water-cementitious ratio by weight.

<sup>2</sup> Unless otherwise permitted, do not use Grade 1 coarse aggregate except in massive foundations with 4-in. minimum clear spacing between reinforcing steel bars. Do not use Grade 1 aggregate in drilled shafts.

<sup>3</sup> Unless otherwise approved, use Grade 8 aggregate in extruded curbs.

<sup>4</sup> For information only.

<sup>5</sup> Structural concrete classes.

<sup>6</sup> As shown on the plans or specified.

<sup>7</sup> Use a minimum cementitious material content of 650 lb/cy of concrete. Do not apply Table 6 over design requirements to Class SS concrete.

**Table 6**  
**Over Design to Meet Compressive Strength Requirements<sup>1</sup>**

No. of Tests <sup>2,3</sup>	Standard Deviation, psi				
	300	400	500	600	700
15	470	620	850	1,120	1,390
20	430	580	760	1,010	1,260
30 or more	400	530	670	900	1,130

1. When designing the mix, add the tabulated amounts to the minimum design strength in Table 5.

2. Number of tests of a concrete mixture used to estimate the standard deviation of a concrete production facility. Test of another mix within 1,000 psi of the specified strength may be used.

3. If less than 15 prior tests are available, the overdesign should be 1,000 psi for specified strength less than 3,000 psi, 1,200 psi for specified strengths from 3,000 to 5,000 psi and 1,400 psi for specified strengths greater than 5,000 psi. For Class K and concrete classes not identified as structural concrete in Table 5 or for Class "C" concrete not used for bridge-class structures, the Engineer may designate on the plans an alternative over-design requirement up to and including 1,000 psi for specified strengths less than 3,000 psi and up to and including 1,200 psi for specified strengths from 3,000 to 5,000 psi.

2. **Aggregates.** Limit the use of recycled crushed hydraulic cement concrete as a coarse or fine aggregate to Class A, B, D, E, and P concrete. Limit recycled crushed concrete fine aggregate to a maximum of 20% of the fine aggregate.

When white hydraulic cement is specified, use light-colored aggregates.

3. **Chemical Admixtures.** Use only preapproved concrete chemical admixtures from the list of prequalified concrete admixtures maintained by the TxDOT Construction Division. Submit non-preapproved admixtures for testing to the Engineer for approval. Do not use high-range water-reducing admixtures (Type F or G) or accelerating admixtures (Type C or E) in bridge deck concrete.

When a corrosion-inhibiting admixture is required, use a 30% calcium nitrite solution. The corrosion inhibiting admixture must be set neutral unless otherwise approved. Dose the admixture at the rate of gallons of admixture per cubic yard of concrete shown on the plans.

4. **Slump.** Unless otherwise specified, provide concrete slump in accordance with Table 7 using the lowest slump possible that can be placed and finished efficiently without segregation or honeycombing.

Concrete that exceeds the maximum acceptable placement slump at time of delivery will be rejected.

When approved, the slump of a given concrete mix may be increased above the values shown in Table 8 using chemical admixtures, provided that the admixture-treated concrete has the same or lower water–cement or water–cementitious-material ratio and does not exhibit segregation or excessive bleeding. Request approval for the mix design sufficiently in advance for proper evaluation by the Engineer.

**Table 7  
Slump Requirements**

<b>Concrete Designation</b>	<b>Recommended Design and Placement Slump, in.</b>	<b>Maximum Acceptable Placement Slump, in.</b>
Drilled shafts	See TxDOT Item 416	See TxDOT Item 416
Thin walled section (9 in. or less)	4	6-1/2
Approach slabs, concrete overlays, caps, columns, piers, wall sections (over 9 in.)	3	5
Bridge slabs	4	5-1/2
Prestressed concrete members <sup>1</sup>	4	6-1/2
Concrete traffic barrier, concrete bridge railing	4	6-1/2
Dense concrete overlay	3/4	2
Latex-modified conc. for bridge deck overlays	3	7-1/2
Concrete placed underwater	6	8-1/2
Concrete pavement (slip-formed)	1-1/2	3
Concrete pavement (formed)	4	6-1/2
Riprap, curb, gutter, slip-formed, and extruded concrete	As approved	As approved

1. If a high-range water reducer (HRWR) is used, maximum acceptable placement slump will be 9 in.

- 5. Mix Design Options.** For structural concrete identified in Table 5 and any other class of concrete designed using more than 520 pounds of cementitious material per cubic yard, use one of the mix design Options 1–8 shown below.

For concrete classes not identified as structural concrete in Table 5 and designed using less than 520 pounds of cementitious material per cubic yard, use one of the mix design Options 1–8 shown below, except that Class C fly ash may be used instead of Class F fly ash for Options 1, 3, and 4 unless sulfate-resistant concrete is shown on the plans.

Do not use mix design options 6 or 7 when High Performance Concrete (HPC) is required. Option 8 may be used when HPC is required provided: a minimum of 20% of the cement is replaced with a Class C fly ash; TxDOT standard laboratory test procedure Tex-440-A, “Initial Time of Set of Fresh Concrete” is performed during mix design verification; the additional requirements for permeability are met; and the concrete is not required to be sulfate-resistant.

- a. Option 1.** Replace 20 to 35% of the cement with Class F fly ash.
- b. Option 2.** Replace 35 to 50% of the cement with GGBFS.
- c. Option 3.** Replace 35 to 50% of the cement with a combination of Class F fly ash, GGBFS, UFFA, metakaolin, or silica fume. However, no more than 35% may be fly ash, and no more than 10% may be silica fume.
- d. Option 4.** Use Type IP or Type IS cement. (Up to 10% of a Type IP or Type IS cement may be replaced with Class F fly ash, GGBFS, or silica fume.)

- e. **Option 5.** Replace 35 to 50% of the cement with a combination of Class C fly ash and at least 6% of silica fume, UFFA, or metakaolin. However, no more than 35% may be Class C fly ash, and no more than 10% may be silica fume.
- f. **Option 6.** Use a lithium nitrate admixture at a minimum dosage of 0.55 gallon of 30% lithium nitrate solution per pound of alkalis present in the hydraulic cement.
- g. **Option 7.** When using hydraulic cement only, confirm that the total alkali contribution from the cement in the concrete does not exceed 4.00 pounds per cubic yard of concrete when calculated as follows:

$$\text{lb. alkali per cu. yd.} = \frac{(\text{lb. cement per cu. yd.}) \times (\% \text{ Na}_2\text{O equivalent in cement})}{100}$$

In the above calculation, use the maximum cement alkali content reported on the cement mill certificate.

- h. **Option 8.** For any deviations from Options 1–7, perform testing on both coarse and fine aggregate separately in accordance with ASTM C 1567. Before use of the mix, provide a certified test report signed and sealed by a licensed professional engineer, from a laboratory on TxDOT's List of Approved ASTM C 1260 Laboratories, demonstrating that the ASTM C-1567 test result for each aggregate does not exceed 0.10% expansion.

When HPC is required, provide a certified test report signed and sealed by a licensed professional engineer demonstrating that AASHTO T 277 test results indicate the permeability of the concrete is less than 1,500 coulombs tested immediately after either of the following curing schedules:

- Moist cure specimens 56 days at 73°F.
- Moist cure specimens 7 days at 73°F followed by 21 days at 100°F.

- B. Trial Batches.** Perform all preliminary trial batches and testing necessary to substantiate the proposed mix designs, and provide documentation including mix design, material proportions, and test results substantiating that the mix design conforms to specification requirements. Once a trial batch substantiates the mix design, the proportions and mixing methods used in the trial batch become the mix design of record.

Make all final trial batches using the proposed ingredients in a mixer that is representative of the mixers to be used on the job. Make the batch size at least 50% of the mixer's rated capacity. Perform fresh concrete tests for air and slump, and make, cure, and test strength specimens for compliance with specification requirements. Test at least 1 set of design strength specimens, consisting of 2 specimens per set, at 7-day, 28-day, and at least one additional age. Before placing, provide the Engineer the option of witnessing final trial batches, including the testing of the concrete. If not provided this option, the Engineer may require additional trial batches, including testing, before the concrete is placed.

Establish 7-day compressive strength target values using the following formula for each concrete mix to be used:

$$\text{Target value} = \text{Minimum design strength} \times \frac{7\text{-day avg. trial batch strength}}{28\text{-day avg. trial batch strength}}$$

When there are changes in aggregates or in type, brand, or source of cement, SCM, or chemical admixtures, reevaluate the mix as a new mix design. A change in vendor does not necessarily constitute a change in materials or source. When only the brand or source of cement is changed and there is a prior record of satisfactory performance of the cement with the ingredients, new trial batches may be waived by the Engineer.

When the maturity method is specified or permitted, establish the strength–maturity relationship in accordance with TxDOT standard laboratory test procedure Tex-426-A. When using the maturity method any changes in any of the ingredients, including changes in proportions, will require the development of a new strength–maturity relationship for the mix.

### C. Storage of Materials.

1. **Cement, Supplementary Cementing Materials, and Mineral Filler.** Store all cement, supplementary cementing materials, and mineral filler in weatherproof enclosures that will protect them from dampness or absorption of moisture.

When permitted, small quantities of sacked cement may be stored in the open, on a raised platform, and under waterproof covering for up to 48 hours.

2. **Aggregates.** Handle and store concrete aggregates in a manner that prevents contamination with foreign materials. If the aggregates are stored on the ground, clear the sites for the stockpiles of all vegetation, level the sites, and do not use the bottom 6 inch layer of aggregate without cleaning the aggregate before use.

When conditions require the use of 2 or more grades of coarse aggregates, maintain separate stockpiles and prevent intermixing. Where space is limited, separate the stockpiles using physical barriers. Store aggregates from different sources in different stockpiles unless the Engineer authorizes pre-blending of the aggregates. Minimize segregation in stockpiles. Remix and test stockpiles when segregation is apparent.

Sprinkle stockpiles to control moisture and temperature as necessary. Maintain reasonably uniform moisture content in aggregate stockpiles.

3. **Admixtures.** Store admixtures in accordance with manufacturer's recommendations and prevent admixtures from freezing.

- D. **Measurement of Materials.** Except for volumetric mixers, measure concrete materials by weight. Measure mixing water, consisting of water added to the batch, ice added to the batch, water occurring as surface moisture on the aggregates, and water introduced in the form of admixtures, by volume or weight. Measure ice by weight. Measure cement and supplementary cementing materials in a weigh hopper and on a separate scale from those used for other materials. Measure the cement first when measuring the cumulative weight. Measure concrete chemical admixtures in powdered form by weight. Measure concrete chemical admixtures in liquid form by weight or volume. Measure batch materials within the tolerances of Table 8.

**Table 8**  
**Measurement Tolerances – Non-Volumetric Mixers**

<b>Material</b>	<b>Tolerance (%)</b>
Cement, wt.	±1
Mineral admixture, wt.	±1
Cement + SCM (cumulative weighing), wt.	±1
Water, wt. or volume	±3
Fine aggregate, wt.	±2
Coarse aggregate, wt.	±2
Fine + coarse aggregate (cumulative weighing), wt.	±1
Chemical admixtures, wt. or volume	±3

When measuring cementitious materials at less than 30% of scale capacity, confirm that the quantity measured is accurate to not less than the required amount and not more than 4% in excess. When measuring aggregates in a cumulative weigh batcher at less than 30% of the scale capacity, confirm that the cumulative quantity is measured accurate to ±0.3% of scale capacity or ±3% of the required cumulative weight, whichever is less.

For volumetric mixers, base tolerances on volume–weight relationship established by calibration, and measure the various ingredients within the tolerances of Table 9.

Correct batch weight measurements for moisture.

When approved, under special circumstances, measure cement in bags of standard weight. Weighing of sacked cement is not required. Do not use fractional bags except for small hand-mixed batches of approximately 5 cubic feet or less and when an approved method of volumetric or weight measurement is used.

**Table 9**  
**Measurement Tolerances – Volumetric Mixers**

<b>Material</b>	<b>Tolerance</b>
Cement, wt. %	0 to +4
SCM, wt. %	0 to +4
Fine aggregate, wt. %	±2
Coarse aggregate, wt. %	±2
Admixtures, wt. or volume %	±3
Water, wt. or volume %	±1

**E. Mixing and Delivering Concrete.** Mix and deliver concrete by means of one of the following operations:

- central-mixed,
- shrink-mixed,
- truck-mixed,
- volumetric mixer-mixed, or
- hand-mixed.

Operate mixers and agitators within the limits of the rated capacity and speed of rotation for mixing and agitation as designated by the manufacturer of the equipment.

For shrink-mixed and truck-mixed concrete, when there is a reason to suspect the uniformity of concrete delivered using a truck mixer or truck agitator, conduct slump tests of 2 individual samples taken after discharging approximately 15% and 85% of the load as a quick check of the probable degree of uniformity. Take the 2 samples within an elapsed time of at most 15 minutes. If the slumps of the 2 samples differ by more than the values shown in Table 10, investigate the causes and take corrective actions including adjusting the batching sequence at the plant and the mixing time and number of revolutions. Delivery vehicles that fail to meet the mixing uniformity requirements must not be used until the condition is corrected.

**Table 10**  
**Slump Tolerance<sup>1</sup>**

<b>Average Slump</b>	<b>Slump Tolerance<sup>2</sup></b>
4 in. or less	1.0 in.
4 to 6 in.	1.5 in.

1. Do not apply these tolerances to the required slumps in Table 8.

2. Maximum permissible difference in results of test of samples from 2 locations in the concrete batch.

Re-tempering or adding concrete chemical admixtures is only permitted at the job site when concrete is delivered in a truck mixer. Do not add water after the introduction of mixing water at the batch plant except on arrival at the job site, with approval, to adjust the slump of the concrete. When this water is added, do not exceed the mix design water-cementitious-material ratio. Turn the drum or blades at least 30 additional revolutions at mixing speed to confirm thorough and uniform mixing of the concrete. Do not add water or chemical admixtures to the batch after any concrete has been discharged.

Maintain concrete delivery and placement rates sufficient to prevent cold joints.

Before unloading, furnish the computer generated delivery ticket for the batch of concrete containing the information required on TxDOT Form 596, "Concrete Batch Ticket."

When the concrete contains silica fume, adjust mixing times and batching operations as necessary to confirm the material is completely and uniformly dispersed in the mix. The dispersion of the silica fume within the mix will be verified by the City, using cylinders made from trial batches. If uniform dispersion is not achieved, make necessary changes to the batching operations until uniform and complete dispersion of the silica fume is achieved.

- 1. Central-Mixed Concrete.** Provide concrete that is mixed completely in a stationary mixer. Mix concrete for a period of 1 minute for 1 cubic yard and 15 seconds for each additional cubic yard of rated capacity of the mixer unless mixer performance test data demonstrate that shorter mixing times can be used to obtain a uniform mix in accordance with TxDOT standard laboratory test procedure Tex-472-A. Count the mixing time from the time all the solid materials are in the drum. Charge the mixer so that some water will enter before the cement and aggregate. Confirm that all water is in the drum by the end of the first  $\frac{1}{4}$  of the specified mixing time. Adjust the mixing time if necessary to achieve a uniform mix. Concrete mixed completely in a stationary mixer must be delivered to the project in a truck mixer, truck agitator, or non-agitating delivery vehicle. When a truck mixer or truck agitator is used for transporting concrete, use the manufacturer's designated agitating speed for any turning during transportation. Non-agitating delivery vehicles must be clean and free of built-up concrete with adequate means to control concrete discharge. Deliver the concrete to the project in a thoroughly mixed and uniform

mass, and discharge the concrete with a satisfactory degree of uniformity. Resolve questions regarding the uniformity of the concrete by testing when directed by the Engineer in accordance with TxDOT standard laboratory test procedure Tex-472-A.

2. **Shrink-Mixed Concrete.** Provide concrete that is first partially mixed in a stationary mixer and then mixed completely in a truck mixer. Partially mix for the minimum time required to intermingle the ingredients in the stationary mixer, and then transfer to a truck mixer and mix the concrete at the manufacturer's designated mixing speed for an adequate amount of time to produce thoroughly mixed concrete. Deliver the concrete to the project in a thoroughly mixed and uniform mass, and discharge the concrete with a satisfactory degree of uniformity.
  3. **Truck-Mixed Concrete.** Mix the concrete in a truck mixer from 70 to 100 revolutions at the mixing speed designated by the manufacturer to produce a uniform concrete mix. Deliver the concrete to the project in a thoroughly mixed and uniform mass and discharge the concrete with a satisfactory degree of uniformity. Additional mixing at the job site at the mixing speed designated by the manufacturer is allowed as long as concrete is discharged before the drum has revolved a total of 300 revolutions after the introduction of the mixing water to the cement and the aggregates.
  4. **Volumetric Mixer-Mixed Concrete.** Unless otherwise specified or permitted, perform all mixing operations in accordance with manufacturer's recommended procedures. Provide an accurate method of measuring all ingredients by volume, and calibrate equipment to assure correct measurement of materials within the specified tolerances.
  5. **Hand-Mixed Concrete.** When permitted, for small placements of less than 2 cubic yards, mix up to a 2 sack batch of concrete by hand methods or in a small motor-driven mixer. For such placements, proportion the mix by volume or weight.
- F. Placing, Finishing, and Curing Concrete.** Place, finish, and cure concrete in accordance with the pertinent Items.
- G. Sampling and Testing of Concrete.** Unless otherwise specified, all fresh and hardened concrete is subject to testing as follows:
1. **Sampling Fresh Concrete.** Provide all material to be tested. Fresh concrete will be sampled for testing at the discharge end if using belt conveyors or pumps. When it is impractical to sample at the discharge end, a sample will be taken at the time of discharge from the delivery equipment and correlation testing will be performed and documented to confirm specification requirements are met at the discharge end.
  2. **Testing of Fresh Concrete.**
    - a. **Air Content.** TxDOT standard laboratory test procedure Tex-414-A or Tex-416-A.
    - b. **Slump.** TxDOT standard laboratory test procedure Tex-415-A.
    - c. **Temperature.** TxDOT standard laboratory test procedure Tex-422-A.
    - d. **Making and Curing Strength Specimens.** TxDOT standard laboratory test procedure Tex-447-A.

3. **Testing of Hardened Concrete.** Only compressive strength testing will be used unless otherwise specified or shown on the plans.
    - a. **Compressive Strength.** TxDOT standard laboratory test procedure Tex-418-A.
    - b. **Flexural Strength.** TxDOT standard laboratory test procedure Tex-448-A.
    - c. **Maturity.** TxDOT standard laboratory test procedure Tex-426-A.
  4. **Certification of Testing Personnel.** Contractor personnel performing testing must be ACI-certified for the tests being performed. Personnel performing these tests are subject to City approval. Use of a commercial laboratory is permitted. All personnel performing testing using the maturity method must be qualified by a training program recognized by TxDOT before using this method on the job.
  5. **Adequacy and Acceptance of Concrete.** The Engineer will sample and test the fresh and hardened concrete for acceptance. The test results will be reported to the Contractor and the concrete supplier. For any concrete that fails to meet the required strengths as outlined below, investigate the quality of the materials, the concrete production operations, and other possible problem areas to determine the cause. Take necessary actions to correct the problem including redesign of the concrete mix. The Engineer may suspend all concrete operations under the pertinent Items if the Contractor is unable to identify, document, and correct the cause of the low strengths in a timely manner. Resume concrete operations only after obtaining approval for any proposed corrective actions.
    - a. **Structural Concrete.** For concrete classes identified as structural concrete in Table 5, the Engineer will make and test 7 day and 28 day specimens. Acceptance will be based on the design strength given in Table 5.

The Engineer will evaluate the adequacy of the concrete by comparing 7 day test results to the target value established in accordance with Section 300.4.B, "Trial Batches."
    - b. **All Other Concrete.** For concrete classes not identified as structural concrete in Table 5, the Engineer will make and test 7-day specimens. The Engineer will base acceptance on the 7 day target value established in accordance with Section 300.4.B, "Trial Batches."
  6. **Test Sample Handling.** Unless otherwise shown on the plans or directed, remove forms and deliver department test specimens to curing facilities, in accordance with pertinent test procedures. Clean and prepare forms for reuse.
- 300.5. MEASUREMENT AND PAYMENT:** The work performed, materials furnished, equipment, labor, tools, and incidentals will not be measured or paid for directly but will be subsidiary to pertinent Items.

**300.6. BID ITEM:**

N/A

## ITEM

### 301 REINFORCING STEEL

**301.1. DESCRIPTION:** *Furnish and place reinforcing steel of the sizes and details shown on the plans.*

**301.2. MATERIALS:**

- A. Approved Mills.** Before furnishing steel, producing mills of reinforcing steel for the City must be pre-approved in accordance with TxDOT's DMS-7320, "Qualification Procedure for Reinforcing Steel Mills," by the TxDOT's Construction Division, which maintains a list of approved producing mills. Reinforcing steel obtained from unapproved sources will not be accepted.
- B. Deformed Bar and Wire Reinforcement.** Unless otherwise shown on the plans, reinforcing steel must be Grade 60, and bar reinforcement must be deformed. Reinforcing steel must conform to one of the following:
- ASTM A 615, Grades 40 or 60;
  - ASTM A 996, Type A, Grades 40 or 60;
  - ASTM A 996, Type R, Grade 60, permitted in concrete pavement only (Furnish ASTM A 996, Type R bars as straight bars only and do not bend them. Bend tests are not required.); or
  - ASTM A 706.

The provisions of this Item take precedence over ASTM provisions.

The nominal size, area, and weight of reinforcing steel bars covered by this Item are shown in Table 1. Designate smooth bars up to No. 4 by size number and above No. 4 by diameter in inches.

- C. Smooth Bar and Spiral Reinforcement.** Smooth bars and dowels for concrete pavement must have a minimum yield strength of 60 ksi and meet ASTM A 615. For smooth bars that are larger than No. 3, provide steel conforming to ASTM A 615 or meet the physical requirements of ASTM A 36.

Spiral reinforcement may be smooth or deformed bars or wire of the minimum size or gauge shown on the plans. Bars for spiral reinforcement must comply with ASTM A 615, Grade 40; ASTM A 996, Type A, Grade 40; or ASTM A 675, Grade 80, meeting dimensional requirements of ASTM A 615. Smooth wire must comply with ASTM A 82, and deformed wire must comply with ASTM A 496.

- D. Weldable Reinforcing Steel.** Reinforcing steel to be welded must comply with ASTM A 706 or have a carbon equivalent (C.E.) of at most 0.55%. A report of chemical analysis showing the percentages of elements necessary to establish C.E. is required for reinforcing steel that does not meet ASTM A 706 to be structurally welded. These requirements do not pertain to miscellaneous welds on reinforcing steel as defined in TxDOT's Section 448.4.B.1.a, "Miscellaneous Welding Applications."

Calculate C.E. using the following formula:

$$C.E. = \%C + \frac{\%Mn}{6} + \frac{\%Cu}{40} + \frac{\%Ni}{20} + \frac{\%Cr}{10} - \frac{\%Mo}{50} - \frac{\%V}{10}$$

- E. Welded Wire Fabric.** For fabric reinforcement, use wire that conforms to ASTM A 82 or A 496. Use wire fabric that conforms to ASTM A 185 or A 497. Observe the relations shown in Table 2 among size number, diameter in inches, and area when ordering wire by size numbers, unless otherwise specified. Precede the size number for deformed wire with “D” and for smooth wire with “W.”

Designate welded wire fabric as shown in the following example: 6 × 12 – W16 × W8 (indicating 6 in. longitudinal wire spacing and 12 in. transverse wire spacing with smooth No. 16 wire longitudinally and smooth No. 8 wire transversely).

**Table 2**  
**Wire Size Number, Diameter, and Area**

Size Number (in.)	Size Number (mm)	Diameter (in.)	Area (sq. in.)
31	200	0.628	0.310
30	194	0.618	0.300
28	181	0.597	0.280
26	168	0.575	0.260
24	155	0.553	0.240
22	142	0.529	0.220
20	129	0.505	0.200
18	116	0.479	0.180
16	103	0.451	0.160
14	90	0.422	0.140
12	77	0.391	0.120
10	65	0.357	0.100
8	52	0.319	0.080
7	45	0.299	0.070
6	39	0.276	0.060
5.5	35	0.265	0.055
5	32	0.252	0.050
4.5	29	0.239	0.045
4	26	0.226	0.040
3.5	23	0.211	0.035
2.9	19	0.192	0.035
2.5	16	0.178	0.025
2	13	0.160	0.020
1.4	9	0.134	0.014
1.2	8	0.124	0.012
0.5	3	0.080	0.005

Note: Size numbers (in.) are the nominal cross-sectional area of the wire in hundredths of a square inch. Size numbers (mm) are the nominal cross-sectional area of the wire in square millimeters. Fractional sizes between the sizes listed above are also available and acceptable for use.

- F. Epoxy Coating.** Epoxy coating will be required as shown on the plans. Before furnishing epoxy-coated reinforcing steel, an epoxy applicator must be pre-approved in accordance with TxDOT’s DMS 7330, “Qualification Procedure for Reinforcing Steel Epoxy Coating Applicators.” The TxDOT Construction Division maintains a list of approved applicators.

Coat reinforcing steel in accordance with Table 3.

**Table 3**  
**Epoxy Coating Requirements for Reinforcing Steel**

Material	Specification
Bar	ASTM A 775 or A 934
Wire or fabric	ASTM A 884 Class A or B
Mechanical couplers	As shown on the plans
Hardware	As shown on the plans

Use epoxy coating material and coating repair material that complies with TxDOT's DMS 8130, "Epoxy Powder Coating for Reinforcing Steel." Do not patch more than ¼-inch total length in any foot at the applicator's plant.

Epoxy-coated reinforcement will be sampled and tested in accordance with TxDOT standard laboratory test procedure Tex-739-I.

Maintain identification of all reinforcing throughout the coating and fabrication and until delivery to the project site.

Furnish 1 copy of a written certification that the coated reinforcing steel meets the requirements of this Item and 1 copy of the manufacturer's control tests.

- G. Mechanical Couplers.** When mechanical splices in reinforcing steel bars are shown on the plans, use couplers of the type specified in TxDOT's DMS-4510, "Mechanical Couplers," under the section "General Requirements."

Furnish only couplers that have been produced by a manufacturer that has been prequalified in accordance with TxDOT's DMS-4510. Do not use sleeve-wedge type couplers on coated reinforcing. Sample and test couplers for use on individual projects in accordance with TxDOT's DMS-4510. Furnish couplers only at locations shown on the plans.

### 301.3. CONSTRUCTION:

- A. Bending.** Cold-bend the reinforcement accurately to the shapes and dimensions shown on the plans. Fabricate in the shop if possible. Field-fabricate, if permitted, using a method approved by the Engineer. Replace improperly fabricated, damaged, or broken bars at no additional expense to the City. Repair damaged or broken bars embedded in a previous concrete placement using a method approved by the Engineer.

Unless otherwise shown on the plans, the inside diameter of bar bends, in terms of the nominal bar diameter (d), must be as shown in Table 4.

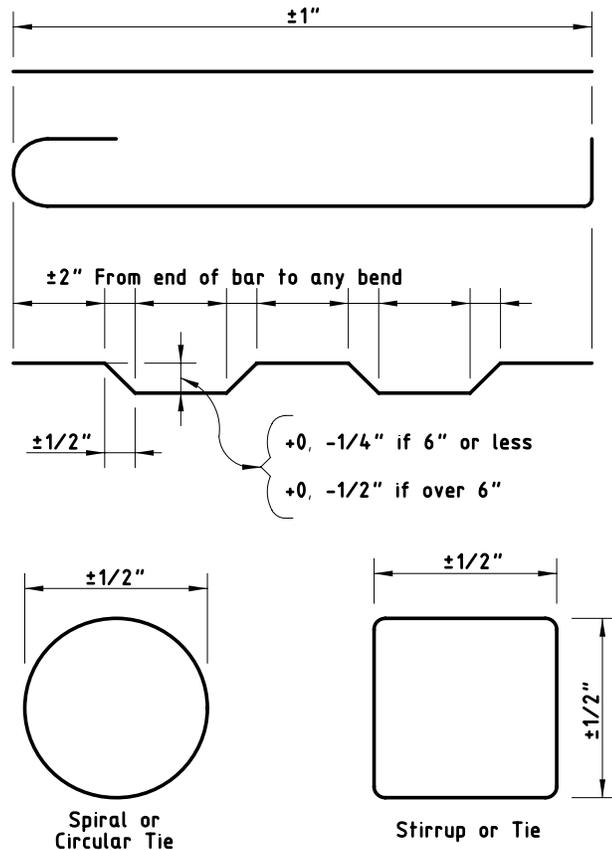
**Table 4**  
**Minimum Inside Diameter of Bar Bends**

Bend	Bar Size Number (in.)	Bar Size Number (mm)	Diameter
Bends of 90° and greater in stirrups, ties, and other secondary bars that enclose another bar in the bend	3, 4, 5	10, 13, 16	4d
	6, 7, 8	19, 22, 25	6d
Bends in main bars and in secondary bars not covered above	3 through 8	10 through 25	6d
	9, 10, 11	29, 32, 36	8d
	14, 18	43, 57	10d

Note: Bar size numbers (in.) are based on the number of eighths of an inch included in the nominal diameter of the bar. Bar size numbers (mm) approximate the number of millimeters included in the nominal diameter of the bar.

Where bending No. 14 or No. 18 Grade 60 bars is required, bend-test representative specimens as described for smaller bars in the applicable ASTM specification. Make the required 90° bend around a pin with a diameter of 10 times the nominal diameter of the bar.

**B. Tolerances.** Fabrication tolerances for bars are shown in Figure 1.



**Figure 1. Fabrication tolerances for bars.**

- C. Storage.** Store steel reinforcement above the ground on platforms, skids, or other supports, and protect it from damage and deterioration. Ensure that reinforcement is free from dirt, paint, grease, oil, and other foreign materials when it is placed in the work. Use reinforcement free from defects such as cracks and delaminations. Rust, surface seams, surface irregularities, or mill scale will not be cause for rejection if the minimum cross-sectional area of a hand wire-brushed specimen meets the requirements for the size of steel specified.
- D. Splices.** Lap-splice, weld-splice, or mechanically splice bars as shown on the plans. Additional splices not shown on the plans will require approval. Splices not shown on the plans will be permitted in slabs 15-inches or less in thickness, columns, walls, and parapets.
- Unless otherwise approved, splices will not be permitted in bars 30 feet or less in plan length. For bars exceeding 30 feet in plan length, the distance center-to-center of splices must be at least 30 feet minus 1 splice length, with no more than 1 individual bar length less than 10 feet. Make lap splices not shown on the plans, but otherwise permitted, in accordance with Table 5. Maintain the specified concrete cover and spacing at splices, and place the lap-spliced bars in contact, securely tied together.

**Table 5**  
**Minimum Lap Requirements for Bar Sizes through No. 11**

Bar Size Number (in.)	Bar Size Number (mm)	Uncoated Lap Length	Coated Lap Length
3	10	1 ft. 4 in.	2 ft. 0 in.
4	13	1 ft. 9 in.	2 ft. 8 in.
5	16	2 ft. 2 in.	3 ft. 3 in.
6	19	2 ft. 7 in.	3 ft. 11 in.
7	22	3 ft. 5 in.	5 ft. 2 in.
8	25	4 ft. 6 in.	6 ft. 9 in.
9	29	5 ft. 8 in.	8 ft. 6 in.
10	32	7 ft. 3 in.	10 ft. 11 in.
11	36	8 ft. 11 in.	13 ft. 5 in.

Note: Bar size numbers (in.) are based on the number of eighths of an inch included in the nominal diameter of the bar. Bar size numbers (mm) approximate the number of millimeters included in the nominal diameter of the bar.

- Do not lap No. 14 or No. 18 bars.
- Lap spiral steel at least 1 turn.
- Splice welded wire fabric using a lap length that includes the overlap of at least 2 cross wires plus 2-inches on each sheet or roll. Splices using bars that develop equivalent strength and are lapped in accordance with Table 5 are permitted.
- For box culvert extensions with less than 1-foot of fill, lap the existing longitudinal bars with the new bars as shown in Table 3. For extensions with more than 1-foot of fill, lap at least 1-foot 0-inch.
- Ensure that welded splices conform to the requirements of the plans and of TxDOT's Item 448, "Structural Field Welding." Field-prepare ends of reinforcing bars if they will be butt-welded. Delivered bars must be long enough to permit weld preparation.

- Install mechanical coupling devices in accordance with the manufacturer's recommendations at locations shown on the plans. Protect threaded male or female connections, and make sure the threaded connections are clean when making the connection. Do not repair damaged threads.
  - Mechanical coupler alternate equivalent strength arrangements, to be accomplished by substituting larger bar sizes or more bars, will be considered if approved in writing before fabrication of the systems.
- E. Placing.** Unless otherwise shown on the plans, dimensions shown for reinforcement are to the centers of the bars. Place reinforcement as near as possible to the position shown on the plans. In the plane of the steel parallel to the nearest surface of concrete, bars must not vary from plan placement by more than 1/12 of the spacing between bars. In the plane of the steel perpendicular to the nearest surface of concrete, bars must not vary from plan placement by more than 1/4-inch. Cover of concrete to the nearest surface of steel must be at least 1-inch unless otherwise shown on the plans.

For bridge slabs, the clear cover tolerance for the top mat of reinforcement is -0, +1/2-inch.

Locate the reinforcement accurately in the forms, and hold it firmly in place before and during concrete placement by means of bar supports that are adequate in strength and number to prevent displacement and to keep the steel at the proper distance from the forms. Support bars by standard bar supports with plastic tips, approved plastic bar supports, or precast mortar or concrete blocks when supports are in contact with removable or stay-in-place forms. Use bright basic bar supports to support reinforcing steel placed in slab overlays on concrete panels or on existing concrete slabs. Bar supports in contact with soil or subgrade must be approved.

For bar supports with plastic tips, the plastic protection must be at least 3/32-inch thick and extend upward on the wire to a point at least 1/2-inch above the formwork.

All accessories such as tie wires, bar chairs, supports, or clips used with epoxy-coated reinforcement must be of steel, fully coated with epoxy or plastic. Plastic supports approved by the Engineer may also be used with epoxy-coated reinforcement.

Cast mortar or concrete blocks to uniform dimensions with adequate bearing area. Provide a suitable tie wire in each block for anchoring to the steel. Cast the blocks to the thickness required in approved molds. The surface placed adjacent to the form must be a true plane, free of surface imperfections. Cure the blocks by covering them with wet burlap or mats for a period of 72-hours. Mortar for blocks should contain approximately 1 part hydraulic cement to 3 parts sand. Concrete for blocks should contain 850 lb. of hydraulic cement per cubic yard of concrete.

Place individual bar supports in rows at 4 feet maximum spacing in each direction. Place continuous type bar supports at 4 feet maximum spacing. Use continuous bar supports with permanent metal deck forms.

The exposure of the ends of longitudinals, stirrups, and spacers used to position the reinforcement in concrete pipe and in precast box culverts or storm drains is not cause for rejection.

Tie reinforcing steel for bridge slabs, top slabs of direct traffic culverts, and top slabs of prestressed box beams at all intersections, except tie only alternate intersections where spacing is less than 1 foot in each direction. For reinforcing steel cages for other structural members, tie the steel at enough intersections to provide a rigid cage of steel. Fasten mats of wire fabric securely at the ends and edges.

Before concrete placement, clean mortar, mud, dirt, debris, oil, and other foreign material from the reinforcement. Do not place concrete until authorized.

If reinforcement is not adequately supported or tied to resist settlement, reinforcement is floating upward, truss bars are overturning, or movement is detected in any direction during concrete placement, stop placement until corrective measures are taken.

#### **F. Handling, Placement, and Repair of Epoxy-Coated Reinforcing Steel.**

- 1. Handling.** Provide systems for handling coated reinforcement with padded contact areas. Pad bundling bands or use suitable banding to prevent damage to the coating. Lift bundles of coated reinforcement with a strongback, spreader bar, multiple supports, or a platform bridge. Transport the bundled reinforcement carefully, and store it on protective cribbing. Do not drop or drag the coated reinforcement.
- 2. Construction Methods.** Do not flame-cut coated reinforcement. Saw or shear-cut only when approved. Coat cut ends as specified in Section 301.3.F.3, "Repair of Coating."

Do not weld or mechanically couple coated reinforcing steel except where specifically shown on the plans. Remove the epoxy coating at least 6-inches beyond the weld limits before welding and 2-inches beyond the limits of the coupler before assembly. After welding or coupling, clean the steel of oil, grease, moisture, dirt, welding contamination (slag or acid residue), and rust to a near-white finish. Check the existing epoxy for damage. Remove any damaged or loose epoxy back to sound epoxy coating.

After cleaning, coat the splice area with epoxy repair material to a thickness of 7 to 17-mils after curing. Apply a second application of repair material to the bar and coupler interface to ensure complete sealing of the joint.

- 3. Repair of Coating.** For repair of the coating, use material that complies with the requirements of this Item and ASTM D 3963. Make repairs in accordance with procedures recommended by the manufacturer of the epoxy coating powder. For areas to be patched, apply at least the same coating thickness as required for the original coating. Repair all visible damage to the coating.

Repair sawed and sheared ends, cuts, breaks, and other damage promptly before additional oxidation occurs. Clean areas to be repaired to ensure that they are free from surface contaminants. Make repairs in the shop or in the field as required.

**301.4. MEASUREMENT AND PAYMENT:** The work performed, materials furnished, equipment, labor, tools, and incidentals will not be measured or paid for directly but will be considered subsidiary to pertinent Items.

**301.5. BID ITEM:**

N/A

**ITEM****303 WELDED WIRE FLAT SHEETS**

**303.1. DESCRIPTION:** *This item shall govern the furnishing of the various sizes of welded wire flat sheets as indicated on the plans or as directed by the Engineer.*

**303.2. MATERIALS:** For fabric reinforcement, use wire that conforms to ASTM A 82 or A 496. Use wire fabric that conforms to ASTM A 185 or A 497. Observe the relations shown in Table 1 among size number, diameter in inches, and area when ordering wire by size numbers, unless otherwise specified. Precede the size number for deformed wire with "D" and for smooth wire with "W." Designate welded wire fabric as shown in the following example:

6 × 12 – W16 × W8 (indicating 6-in. longitudinal wire spacing and 12-in. transverse wire spacing with smooth No. 16 wire longitudinally and smooth No. 8 wire transversely).

Welded wire rolls shall not be used.

**303.3. EQUIPMENT:** Provide the machinery, tools and equipment necessary for proper prosecution of the work. All machinery, tools and equipment used shall be maintained in a satisfactory and workmanlike manner.

**303.4. CONSTRUCTION:** Splice welded wire fabric using a lap length that includes the overlap of at least 2 cross wires plus 2 in. on each sheet.

Distances from forms or concrete surfaces shall be maintained by means of stays, precast blocks, ties, hangers, metal chairs or other approved supports. The use of pebbles, pieces of broken stones or brick, metal pipe and wooden blocks shall not be permitted.

At the edge of the construction, the wire fabric shall not be less than 1 inch nor more than 3 inches from the edge of the concrete and shall have no wires projecting beyond the last member parallel to the edge of the concrete.

**303.5. MEASUREMENT:** No measurement of welded wire flat sheets will be made.

**303.6. PAYMENT:** No direct payment for furnishing and placing welded wire flat sheets will be made. All materials and labor required will be considered subsidiary to the item in which it is used and shall be included in the unit price bid for said item.

**303.7. BID ITEM:**

N/A

**Table 1**  
**Wire Size Number, Diameter, and Area**

Size Number (in.)	Size Number (mm)	Diameter (in.)	Area (sq. in.)
31	200	0.628	0.310
30	194	0.618	0.300
28	181	0.597	0.280
26	168	0.575	0.260
24	155	0.553	0.240
22	142	0.529	0.220
20	129	0.505	0.200
18	116	0.479	0.180
16	103	0.451	0.160
14	90	0.422	0.140
12	77	0.391	0.120
10	65	0.357	0.100
8	52	0.319	0.080
7	45	0.299	0.070
6	39	0.276	0.060
5.5	35	0.265	0.055
5	32	0.252	0.050
4.5	29	0.239	0.045
4	26	0.226	0.040
3.5	23	0.211	0.035
2.9	19	0.192	0.035
2.5	16	0.178	0.025
2	13	0.16	0.020
1.4	9	0.134	0.014
1.2	8	0.124	0.012
0.5	3	0.08	0.005

Note: Size numbers (in.) are the nominal cross-sectional area of the wire in hundredths of a square inch. Size numbers (mm) are the nominal cross-sectional area of the wire in square millimeters. Fractional sizes between the sizes listed above are also available and acceptable for use.

## ITEM

### 307 CONCRETE STRUCTURES

**307.1. DESCRIPTION:** *Construct concrete structures.*

**307.2. MATERIALS:**

- A. Concrete.** Provide concrete conforming to Item 300, “Concrete.” For each type of structure or unit, provide the class of concrete shown on the plans or in pertinent governing specifications.
- B. Grout or Mortar.** Provide grout or mortar conforming to Section 300.2.F, “Mortar and Grout.”
- C. Latex.** Provide an acrylic-polymer latex admixture (acrylic resin emulsion per TxDOT’s DMS-4640, “Chemical Admixtures for Concrete”) suitable for producing polymer-modified concrete or mortar. Do not allow latex to freeze.
- D. Reinforcing Steel.** Provide reinforcing steel conforming to Item 301, “Reinforcing Steel.”
- E. Expansion Joint Material.** Provide materials that conform to the requirements of TxDOT’s DMS-6310, “Joint Sealants and Fillers”:
- Provide preformed fiber expansion joint material that conforms to the dimensions shown on the plans. Provide preformed bituminous fiber material unless otherwise specified.
  - Provide a Class 4, 5, or 7 low-modulus silicone sealant unless otherwise directed.
  - Provide asphalt board that conforms to dimensions shown on the plans.
  - Provide re-bonded neoprene filler that conforms to the dimensions shown on the plans.
- F. Waterstop.** Provide rubber or polyvinyl chloride (PVC) waterstops that conform to TxDOT’s DMS-6160, “Waterstops, Nylon Reinforced Neoprene Sheet, and Elastomeric Pads,” unless otherwise shown on the plans.
- G. Evaporation Retardants.** Provide evaporation retardants that conform to the requirements of TxDOT’s DMS-4650, “Hydraulic Cement Concrete Curing Materials and Evaporation Retardants.”
- H. Curing Materials.** Provide membrane curing compounds that conform to the requirements of TxDOT’s DMS-4650, “Hydraulic Cement Concrete Curing Materials and Evaporation Retardants.”

Provide cotton mats that consist of a filling material of cotton “bat” or “bats” (at least 12 ounces per square yard) completely covered with unsized cloth (at least 6 oz. per square yard) stitched longitudinally with continuous parallel rows of stitching spaced at less than 4 inches, or tuft both longitudinally and transversely at intervals less than 3 inches. Provide cotton mats that are free from tears and in good general condition. Provide a flap at least 6 inches wide consisting of 2 thicknesses of the covering and extending along 1 side of the mat.

Provide polyethylene sheeting that is at least 4 mils thick and free from visible defects. Provide only clear or opaque white sheeting when the ambient temperature during curing exceeds 60°F or when applicable to control temperature during mass pours.

Provide burlap-polyethylene mats made from burlap impregnated on 1 side with a film of opaque white pigmented polyethylene, free from visible defects. Provide laminated mats that have at least 1 layer of an impervious material such as polyethylene, vinyl plastic, or other acceptable material (either as a solid sheet or impregnated into another fabric) and are free of visible defects.

- I. Epoxy.** Unless otherwise specified, provide epoxy materials that conform to TxDOT's DMS-6100, "Epoxy and Adhesives."
- J. Cast Iron Castings.** Provide cast iron castings that conform to Item 409, "Cast Iron Castings."
- K. Metal for Structures.** Provide metal for structures that conform to Item 302, "Metal for Structures."

### 307.3. EQUIPMENT:

**A. Fogging Equipment.** Use fogging equipment that can apply water in a fine mist, not a spray. Produce the fog using equipment that pumps water or water and air under high pressure through a suitable atomizing nozzle. Use hand-held mechanical equipment portable enough to use in the direction of any prevailing wind and adaptable for intermittent use to prevent excessive wetting of the concrete.

**B. Transporting and Placing Equipment.** Use appropriate transporting and placing equipment such as buckets, chutes, buggies, belt conveyors, pumps, or other equipment as necessary. Do not transport or convey concrete through equipment made of aluminum. Use carts with pneumatic tires for carting or wheeling concrete over newly placed slabs.

Use tremies to control the fall of concrete or for underwater placement. Use tremies that are watertight and of large enough diameter to allow the placement of the concrete but less than 14 inches in diameter. For underwater placements, construct the tremie so that the bottom can be sealed and opened once the tremie has been fully charged with concrete.

Use pumps with lines at least 5 inches I.D. where Grade 2 or smaller coarse aggregate is used and at least 8 inches I.D. for Grade 1 coarse aggregate.

**C. Vibrators.** Use immersion-type vibrators that maintain a speed of 6,000 impulses per minute for consolidation of concrete. Provide at least 1 standby vibrator for emergency use.

**D. Screeds and Work Bridges for Bridge Slabs.** For bridge slabs use a self-propelled transverse screed or a mechanical longitudinal screed. Use transverse screeds that are able to follow the skew of the bridge for skews greater than 15° unless otherwise approved. Equip transverse screeds with a pan float. Manually operated screeding equipment may be used if approved for top slabs of culverts, small placements, or unusual conditions. Use screeds that are rigid and heavy enough to hold true to shape and have sufficient adjustments to provide for the required camber or section. Equip the screeds, except those of the roller drum type, with metal cutting edges.

- For bridge slabs, use sufficient work bridges for finishing operations. Mount a carpet drag to a work bridge or a moveable support system that can vary the area of carpet in contact with the concrete. Use carpet pieces long enough to cover the entire width of the placement. Splice or overlap the carpet as necessary. Confirm that enough carpet is in contact longitudinally with the concrete being placed to provide the desired surface finish. Use artificial grass-type carpeting having a molded polyethylene pile face with a blade length between 5/8 and 1 inch and with a minimum weight of 70 oz. per square yard. Confirm that the carpet has a strong, durable backing not subject to rot and that the facing is adequately bonded to the backing to withstand the intended use. A burlap drag, attached to the pan float on a transverse screed, may be used instead of the carpet drag.
- E. Temperature Recording Equipment.** For mass concrete operations or as otherwise specified, use strip chart temperature recording devices, recording maturity meters in accordance with TxDOT standard laboratory test procedure Tex-426-A, or other approved devices that are accurate to within  $\pm 2^{\circ}\text{F}$  within the range of 32 to 212 $^{\circ}\text{F}$ .
- F. Artificial Heating Equipment.** Use artificial heating equipment as necessary for maintaining the concrete temperatures as specified in Section 307.4.G.11, "Placing Concrete in Cold Weather."
- G. Sawing Equipment.** Use sawing equipment capable of cutting grooves in completed bridge slabs and top slabs of direct-traffic culverts. Provide grooves that are 1/8 to 3/16 inch deep and nominally 1/8 inch wide. Groove spacing may range from 5/8 to 1 inch. Use sawing equipment capable of cutting grooves in hardened concrete to within 18 inches of the barrier rail or curb.
- H. Spraying Equipment.** Use mechanically powered pressure sprayers, either air or airless, with appropriate atomizing nozzles for the application of membrane curing. Mechanically driven spraying equipment, adaptable to the rail system used by the screeds, may be used for applying membrane curing to bridge slabs. If approved, use hand-pressurized spray equipment equipped with 2 or 3 fan-spray nozzles. Confirm that the spray from each nozzle overlaps the spray from adjacent nozzles by approximately 50%.
- I. Concrete Testing Equipment.** Provide testing equipment for use by the Engineer in accordance with Section 300.3.C, "Testing Equipment."
- 307.4. CONSTRUCTION:** Before starting work, obtain approval for proposed construction methods. Approval of construction methods and equipment does not relieve the Contractor's responsibility for safety or correctness of methods, adequacy of equipment, or completion of work in full accordance with the Contract.

Unless otherwise shown on the plans, it is the Contractor's option to perform testing on structural concrete (structural classes of concrete are identified in Table 5 of Section 300.4.A, "Classification and Mix Design") to determine the in-situ strength to address the schedule restrictions in Section 307.4.A, "Schedule Restrictions." The Engineer may require the Contractor to perform this testing for concrete placed in cold weather. For Contractor-performed testing, make enough test specimens to confirm that strength requirements are met for the operations listed in Section 307.4.A. Make at least 1 set of test specimens for each element cast each day. Cure these specimens under the same conditions as the portion of the structure involved for all stages of construction. Confirm safe handling, curing, and storage of all test specimens. Provide testing personnel, and sample and test the hardened concrete in accordance with Section 300.4.G, "Sampling and Testing of Concrete." The maturity method, TxDOT standard laboratory test

procedure Tex-426-A, may be used for in-situ strength determination for schedule restrictions if approved. Coring will not be allowed for in-situ strength determination for schedule restrictions. Provide the Engineer the opportunity to witness all testing operations. Report all test results to the Engineer.

If the Contractor does not wish to perform schedule restriction testing, the Engineer's 7 day lab-cured tests, performed in accordance with Section 300.4.G.5, "Adequacy and Acceptance of Concrete," will be used for schedule restriction determinations. The Engineer may require additional time for strength gain to account for field curing conditions such as cold weather.

**A. Schedule Restrictions.** Unless otherwise shown on the plans, construct and open completed structures to traffic with the following limitations:

- 1. Setting Forms.** Attain at least 2,500 psi compressive strength before erecting forms on concrete footings supported by piling or drilled shafts, or on individual drilled shafts. Erect forms on spread footings and culvert footings after the footing concrete has aged at least 2 curing days as defined in Section 307.4.J, "Curing Concrete." Place concrete only after the forms and reinforcing steel have been inspected by the Engineer.

Support tie beam or cap forms by falsework on previously placed tie beams only if the tie beam concrete has attained a compressive strength of 2,500 psi and the member is properly supported to eliminate stresses not provided for in the design. Maintain curing as required until completion of the curing period.

Place superstructure forms or falsework on the substructure only if the substructure concrete has attained a compressive strength of 3,000 psi.

- 2. Removal of Forms and Falsework.** Keep in place weight-supporting forms and falsework for bridge components and culvert slabs until the concrete has attained a compressive strength of 2,500 psi in accordance with Section 307.4.K, "Removal of Forms and Falsework." Keep all forms for mass placements defined in Section 307.4.G.14, "Mass Placements," in place for 4 days following concrete placement.
- 3. Placement of Superstructure Members.** Do not place superstructure members before the substructure concrete has attained a compressive strength of 3,000 psi.
- 4. Longitudinal Screeding of Bridge Slabs.** Place a longitudinal screed directly on previously placed concrete slabs to check and grade an adjacent slab only after the previously placed slab has aged at least 24 hours. Place and screed the concrete after the previously placed slabs have aged at least 48 hours. Maintain curing of the previously placed slabs during placement.
- 5. Staged Placement of Bridge Slabs on Continuous Steel Units.** When staged placement of a slab is required, confirm that the previously placed concrete attains a compressive strength of 3,000 psi before placing the next stage placement. Multiple stages may be placed in a single day if approved.
- 6. Storage of Materials on the Structure.** Obtain approval to store materials on completed portions of a structure once a compressive strength of 3,000 psi has been attained. Maintain proper curing if materials will be stored on structures before completion of curing.

7. **Placement of Equipment and Machinery.** Do not place erection equipment or machinery on the structure until the concrete has attained the design strength specified in Section 300.4.A, "Classification and Mix Design," unless otherwise approved.
  8. **Carting of Concrete.** Once the concrete has attained a compressive strength of 3,000 psi, it may be carted, wheeled, or pumped over completed slabs. Maintain curing during these operations.
  9. **Placing Bridge Rails.** Reinforcing steel and concrete for bridge rails may be placed on bridge slabs once the slab concrete has attained a compressive strength of 3,000 psi. If slipforming methods are used for railing concrete, confirm the slab concrete has attained its design strength specified in Section 300.4.A, "Classification and Mix Design," before placing railing concrete.
  10. **Opening to Construction Traffic.** Bridges and direct-traffic culverts may be opened to all construction traffic when the design strength specified in Section 300.4.A, "Classification and Mix Design," has been attained if curing is maintained.
  11. **Opening to Full Traffic.** Bridges and direct-traffic culverts may be opened to the traveling public when the design strength specified in Section 300.4.A, "Classification and Mix Design," has been attained for all structural elements including railing subject to impact from traffic, when curing has been completed for all slabs, and when the concrete surface treatment has been applied in accordance with TxDOT's Item 428, "Concrete Surface Treatment." Obtain approval before opening bridges and direct-traffic culverts to the traveling public. Other noncritical structural and nonstructural concrete may be opened for service upon the completion of curing unless otherwise specified or directed.
  12. **Post-Tensioned Construction.** For structural elements designed to be post-tensioned confirm that strength requirements on the plans are met for stressing and staged loading of structural elements.
  13. **Backfilling.** Backfill in accordance with TxDOT's Section 400.3.C, "Backfill."
- B. Plans for Falsework and Forms.** Submit 2 copies of plans for falsework and forms for piers, superstructure spans over 20 feet long, bracing systems for girders when the overhang exceeds 3 feet 6 inches, and bridge widening details. Submit similar plans for other units of the structure as directed. Show all essential details of proposed forms, falsework, and bracing. Have a licensed professional engineer design, seal, and sign these plans. City approval is not required, but the City reserves the right to request modifications to the plans. The Contractor is responsible for the adequacy of these plans.
- C. Falsework.** Design and construct falsework to carry the maximum anticipated loads safely, including wind loads, and to provide the necessary rigidity. Submit details in accordance with Section 307.4.B, "Plans for Falsework and Forms."

Design job-fabricated falsework assuming a weight of 150 pcf for concrete, and include a liveload allowance of 50 psf of horizontal surface of the form. Do not exceed 125% of the allowable stresses used by the City for the design of structures.

For commercially produced structural units used in falsework, do not exceed the manufacturer's maximum allowable working loads for moment and shear or end reaction.

Include a liveload allowance of 35 psf of horizontal form surface in determining the maximum allowable working load for commercially produced structural units.

Provide timber that is sound, in good condition, and free from defects that would impair its strength. Provide timber that meets or exceeds the species, size, and grade requirements in the submitted falsework plans.

Provide wedges made of hardwood or metal in pairs to adjust falsework to desired elevations to confirm even bearing. Do not use wedges to compensate for incorrectly cut bearing surfaces.

Use sills or grillages that are large enough to support the superimposed load without settlement. Take precautions to prevent settling of the supporting material unless the sills or grillages are founded on solid rock, shale, or other hard materials.

Place falsework that cannot be founded on a satisfactory spread footing on piling or drilled shafts with enough bearing capacity to support the superimposed load without settlement. Drive falsework piling to the required resistance determined by the applicable formula in TxDOT Item 404, "Driving Piling." Design drilled shafts for falsework to carry the superimposed load using both skin friction and point bearing.

Weld in conformance with TxDOT Item 448, "Structural Field Welding." Securely brace each falsework bent to provide the stiffness required, and securely fasten the bracing to each pile or column it crosses.

Remove falsework when it is no longer required or as indicated on the submitted falsework plan. Pull or cut off foundations for falsework at least 2 feet below finished ground level. Completely remove falsework, piling, or drilled shafts in a stream, lake, or bay to the approved limits to prevent obstruction to the waterway.

**D. Forms.** Submit formwork plans in accordance with Section 307.4.B, "Plans for Falsework and Forms."

**1. General.** Except where otherwise specified or permitted, provide forms of either timber or metal.

Design forms for the pressure exerted by a liquid weighing 150 pcf. Take the rate of concrete placement into consideration in determining the depth of the equivalent liquid. Include a liveload allowance of 50 psf of horizontal surface for job-fabricated forms. Do not exceed 125% of the allowable stresses used by the City for the design of structures.

For commercially produced structural units used for forms, do not exceed the manufacturer's maximum allowable working loads for moment and shear or end reaction. Include a liveload allowance of 35 psf of horizontal form surface in determining the maximum allowable working load for commercially produced structural units.

Provide steel forms for round columns unless otherwise approved. Refer to Item 311, "Concrete Surface Finish," for additional requirements for off-the-form finishes.

Provide commercial form liners for imprinting a pattern or texture on the concrete surface as shown on the plans and specified in TxDOT's Section 427.4.B.2.d, "Form Liner Finish."

Provide forming systems that are practically mortar-tight, rigidly braced, and strong enough to prevent bulging between supports, and maintain them to the proper line and grade during concrete placement. Maintain forms in a manner that prevents warping and shrinkage. Do not allow offsets at form joints to exceed 1/16 inch.

For forms to be left in place, use only material that is inert, non-biodegradable, and non-absorptive.

Attachment of forms or screed supports for bridge slabs to steel I beams or girders may be by welding subject to the following requirements:

- Do not weld to tension flanges or to areas indicated on the plans.
- Weld in accordance with Item 448, "Structural Field Welding."

Take into account:

- deflections due to cast-in-place slab concrete and railing shown in the dead load deflection diagram in the setting of slab forms,
- differential beam or girder deflections due to skew angles and the use of certain stay-in-place slab forming systems, and
- deflection of the forming system due to the wet concrete.

For bridge approach slabs, securely stake forms to line and grade and maintain in position. Rigidly attach inside forms for curbs to the outside forms.

Construct all forms to permit their removal without marring or damaging the concrete. Clean all forms and footing areas of any extraneous matter before placing concrete. Provide openings in forms if needed for the removal of laitance or foreign matter

Treat the facing of all forms with bond-breaking coating of composition that will not discolor or injuriously affect the concrete surface. Take care to prevent coating of the reinforcing steel.

Complete all preparatory work before requesting permission to place concrete.

If the forms show signs of bulging or sagging at any stage of the placement, cease placement and remove the portion of the concrete causing this condition immediately if necessary. Reset the forms and securely brace them against further movement before continuing the placement.

2. **Timber Forms.** Provide properly seasoned good-quality lumber that is free from imperfections that would affect its strength or impair the finished surface of the concrete. Provide timber or lumber that meets or exceeds the requirements for species and grade in the submitted formwork plans.

Maintain forms or form lumber that will be reused so that it stays clean and in good condition. Do not use any lumber that is split, warped, bulged, or marred or that has defects that will produce inferior work, and promptly remove such lumber from the work.

Provide form lining for all formed surfaces except:

- the inside of culvert barrels, inlets, manholes, and box girders;
- the bottom of bridge slabs between beams or girders;
- surfaces that are subsequently covered by backfill material or are completely enclosed; and
- any surface formed by a single finished board or by plywood.

Provide form lining of an approved type such as masonite or plywood. Do not provide thin membrane sheeting such as polyethylene sheets for form lining.

Use plywood at least  $\frac{3}{4}$  inch thick. Place the grain of the face plies on plywood forms parallel to the span between the supporting studs or joists unless otherwise indicated on the submitted form drawings.

Use plywood for forming surfaces that remain exposed that meets the requirements for B-B Plyform Class I or Class II Exterior of the U.S. Department of Commerce Voluntary Product Standard PS 1.

Space studs and joists so that the facing form material remains in true alignment under the imposed loads.

Space wales closely enough to hold forms securely to the designated lines, scabbed at least 4 feet on each side of joints to provide continuity. Place a row of wales near the bottom of each placement.

Place facing material with parallel and square joints, securely fastened to supporting studs.

For surfaces exposed to view and receiving only an ordinary surface finish as defined in Section 307.4.M, "Ordinary Surface Finish," place forms with the form panels symmetrical (long dimensions set in the same direction). Make horizontal joints continuous.

Make molding for chamfer strips or other uses of materials of a grade that will not split when nailed and that can be maintained to a true line without warping. Dress wood molding on all faces. Unless otherwise shown on the plans, fill forms at all sharp corners and edges with triangular chamfer strips measuring  $\frac{3}{4}$  inch on the sides.

To hold forms in place, use metal form ties of an approved type or a satisfactory substitute of a type that permits ease of removal of the metal. Cut back wire ties at least  $\frac{1}{2}$  inch from the face of the concrete.

Use devices to hold metal ties in place that are able to develop the strength of the tie and adjust to allow for proper alignment.

Entirely remove metal and wooden spreaders that separate the forms as the concrete is being placed.

Provide adequate clean-out openings for narrow walls and other locations where access to the bottom of the forms is not readily attainable.

- 3. Metal Forms.** Requirements for timber forms regarding design, mortar-tightness, filleted corners, beveled projections, bracing, alignment, removal, reuse, and wetting also apply to metal forms except that metal forms do not require lining unless specifically noted on the plans.

Use form metal thick enough to maintain the true shape without warping or bulging. Countersink all bolt and rivet heads on the facing sides. Design clamps, pins, or other connecting devices to hold the forms rigidly together and to allow removal without damage to the concrete. Use metal forms that present a smooth surface and that line up properly. Keep metal free from rust, grease, and other foreign materials.

- 4. Form Supports for Overhang Slabs.** Form supports that transmit a horizontal force to a steel girder or beam or to a prestressed concrete beam are permitted provided a satisfactory structural analysis has been made of the effect on the girder or beam as indicated in the submitted formwork plans.

When overhang brackets are used on prestressed concrete beam spans with slab overhangs not exceeding 3 feet 6 inches, use beam bracing as indicated in the plans. For spans with overhangs exceeding this amount, use additional support for the outside beams regardless of the type of beam used. Submit details of the proposed bracing system in accordance with Section 307.4.B, "Plans for Falsework and Forms."

Punch or drill holes full size in the webs of steel members for support of overhang brackets, or torch-cut them to 1/4 inch under size and ream them full size. Do not burn the holes full size. Leave the holes open unless otherwise shown on the plans. Never fill the holes by welding.

- E. Drains.** Install and construct weep holes and roadway drains as shown on the plans.

- F. Placing Reinforcement.** Place reinforcement as provided in Item 301, "Reinforcing Steel." Do not weld reinforcing steel supports to I beams or girders or to reinforcing steel except where shown on the plans.

Place post-tensioning ducts in accordance with the approved prestressing details and in accordance with TxDOT's Item 426, "Prestressing." Keep ducts free of obstructions until all post-tensioning operations are complete.

- G. Placing Concrete.** Give the Engineer sufficient advance notice before placing concrete in any unit of the structure to permit the inspection of forms, reinforcing steel placement, and other preparations.

Follow the sequence of placing concrete shown on the plans or specified.

Do not place concrete when impending weather conditions would impair the quality of the finished work. If conditions of wind, humidity, and temperature are such that concrete cannot be placed without the potential for shrinkage cracking, place concrete in early morning or at night or adjust the placement schedule for more favorable weather. Consult the evaporation rate nomograph in the Portland Cement Association's Design and Control of Concrete Mixtures for shrinkage cracking potential. When mixing, placing, and finishing concrete in non-daylight hours, adequately illuminate the entire placement site as approved.

If changes in weather conditions require protective measures after work starts, furnish adequate shelter to protect the concrete against damage from rainfall or from freezing temperatures as outlined in this Item. Continue operations during rainfall only if approved. Use protective coverings for the material stockpiles. Cover aggregate stockpiles only to the extent necessary to control the moisture conditions in the aggregates.

Allow at least 1 curing day after the concrete has achieved initial set before placing strain on projecting reinforcement to prevent damage to the concrete.

**1. Placing Temperature.** Place concrete according to the following temperature limits for the classes of concrete defined in Section 300.4.A, "Classification and Mix Design":

- Place Class C, F, H, K, or SS concrete only when its temperature at time of placement is between 50 and 95°F. Increase the minimum placement temperature to 60°F if ground-granulated blast furnace (GGBF) slag is used in the concrete.
  - When used in a bridge slab or in the top slab of a direct-traffic culvert, place Class CO, DC, or S concrete only when its temperature at the time of placement is between 50 and 85°F. Increase the minimum placement temperature to 60°F if GGBF slag is used in the concrete. The maximum temperature increases to 95°F if these classes are used for other applications.
  - Place Class A, B, and D concrete only when its temperature at the time of placement is greater than 50°F.
  - Place mass concrete, defined by Section 307.4.G.14, "Mass Placements," only when its temperature at the time of placement is between 50 and 75°F.
- 2. Transporting Time.** Place concrete delivered in agitating trucks within 60 minutes after batching. Place concrete delivered in non-agitating equipment within 45 minutes after batching. Revise the concrete mix design as necessary for hot weather or other conditions that contribute to quick setting of the concrete. Submit for approval a plan to demonstrate that these time limitations can be extended while ensuring the concrete can be properly placed, consolidated, and finished without the use of additional water.
- 3. Workability of Concrete.** Place concrete with a slump as specified in Section 300.4.A.5, "Slump." Concrete that exceeds the maximum slump will be rejected. Water may be added to the concrete before discharging any concrete from the truck to adjust for low slump provided that the maximum mix design water-cement ratio is not exceeded. After introduction of any additional water or chemical admixtures, mix concrete in accordance with Section 300.4.E, "Mixing and Delivering Concrete." Do not add water or chemical admixtures after any concrete has been discharged.
- 4. Transporting Concrete.** Use a method and equipment capable of maintaining the rate of placement shown on the plans or required by this Item to transport concrete to the forms. Transport concrete by buckets, chutes, buggies, belt conveyors, pumps, or other methods.

Protect concrete transported by conveyors from sun and wind to prevent loss of slump and workability. Shade or wrap with wet burlap pipes through which concrete is pumped as necessary to prevent loss of slump and workability.

Arrange and use chutes, troughs, conveyors, or pipes so that the concrete ingredients will not be separated. When necessary to prevent segregation, terminate such equipment in vertical downspouts. Extend open troughs and chutes, if necessary, down inside the forms or through holes left in the forms.

Keep all transporting equipment clean and free from hardened concrete coatings. Discharge water used for cleaning clear of the concrete.

5. **Preparation of Surfaces.** Thoroughly wet all forms, prestressed concrete panels, T beams, and concrete box beams on which concrete is to be placed before placing concrete on them. Remove any remaining puddles of excess water before placing concrete. Provide surfaces that are in a moist, saturated surface-dry condition when concrete is placed on them.

Confirm that the subgrade or foundation is moist before placing concrete for bridge approach slabs or other concrete placed on grade. Lightly sprinkle the subgrade if dry.

6. **Expansion Joints.** Construct joints and devices to provide for expansion and contraction in accordance with plan details and the requirements of this Section and TxDOT's Item 454, "Bridge Expansion Joints."

Prevent bridging of concrete or mortar around expansion joint material in bearings and expansion joints.

Use forms adaptable to loosening or early removal in construction of all open joints and joints to be filled with expansion joint material. To avoid expansion or contraction damage to the adjacent concrete, loosen these forms as soon as possible after final concrete set to permit free movement of the span without requiring full form removal.

When the plans show a Type A joint, provide preformed fiber joint material in the vertical joints of the roadway slab, curb, median, or sidewalk, and fill the top 1 inch with the specified joint sealing material unless noted otherwise. Install the sealer in accordance with TxDOT's Item 438, "Cleaning and Sealing Joints and Cracks (Rigid Pavement and Bridge Decks)," and the manufacturer's recommendations.

Use light wire or nails to anchor any preformed fiber joint material to the concrete on 1 side of the joint.

Confirm that finished joints conform to the plan details with the concrete sections completely separated by the specified opening or joint material.

Remove all concrete within the joint opening soon after form removal and again where necessary after surface finishing to confirm full effectiveness of the expansion joint.

7. **Construction Joints.** A construction joint is the joint formed by placing plastic concrete in direct contact with concrete that has attained its initial set. Monolithic placement means that the manner and sequence of concrete placing does not create a construction joint.

Make construction joints of the type and at the locations shown on the plans. Do not make joints in bridge slabs not shown on the plans unless approved. Additional joints in

other members are not permitted without approval. Place authorized additional joints using details equivalent to those shown on the plans for joints in similar locations.

Unless otherwise required, make construction joints square and normal to the forms. Use bulkheads in the forms for all vertical joints.

Thoroughly roughen the top surface of a concrete placement terminating at a horizontal construction joint as soon as practical after initial set is attained.

Thoroughly clean the hardened concrete surface of all loose material, laitance, dirt, and foreign matter, and saturate it with water. Remove all free water and moisten the surface before concrete or bonding grout is placed against it.

Draw forms tight against the existing concrete to avoid mortar loss and offsets at joints.

Coat the joint surface with bonding mortar, grout, epoxy, or other material as indicated in the plans or other Items. Provide Type V epoxy per TxDOT's DMS-6100, "Epoxies and Adhesives," for bonding fresh concrete to hardened concrete. Place the bonding epoxy on a clean, dry surface, and place the fresh concrete while the epoxy is still tacky. Place bonding mortar or grout on a surface that is saturated surface-dry, and place the concrete before the bonding mortar or grout dries. Place other bonding agents in accordance with the manufacturer's recommendations.

- 8. Handling and Placing.** Minimize segregation of the concrete and displacement of the reinforcement when handling and placing concrete. Produce a uniform dense compact mass.

Do not allow concrete to free-fall more than 5 feet except in the case of drilled shafts, thin walls such as in culverts, or as allowed by other Items. Remove any hardened concrete splatter ahead of the plastic concrete.

Fill each part of the forms by depositing concrete as near its final position as possible. Do not deposit large quantities at 1 point and run or work the concrete along the forms.

Deposit concrete in the forms in layers of suitable depth but not more than 36 inches deep unless otherwise permitted.

Avoid cold joints in a monolithic placement. Sequence successive layers or adjacent portions of concrete so that they can be vibrated into a homogeneous mass with the previously placed concrete before it sets. When re-vibration of the concrete is shown on the plans, allow at most 1 hour to elapse between adjacent or successive placements of concrete except as otherwise allowed by an approved placing procedure. This time limit may be extended by ½ hour if the concrete contains at least a normal dosage of retarding admixture.

Use an approved retarding agent to control stress cracks and cold joints in placements where differential settlement and setting time may induce cracking.

- 9. Consolidation.** Carefully consolidate concrete and flush mortar to the form surfaces with immersion type vibrators. Do not use vibrators that operate by attachment to forms or reinforcement except where approved on steel forms.

Vibrate the concrete immediately after deposit. Systematically space points of vibration to confirm complete consolidation and thorough working of the concrete around the reinforcement, embedded fixtures, and into the corners and angles of the forms. Insert the vibrator vertically where possible except for slabs where it may be inserted in a sloping or horizontal position. Vibrate the entire depth of each lift, allowing the vibrator to penetrate several inches into the preceding lift. Do not use the vibrator to move the concrete to other locations in the forms. Do not drag the vibrator through the concrete. Thoroughly consolidate concrete along construction joints by operating the vibrator along and close to but not against the joint surface. Continue the vibration until the concrete surrounding reinforcements and fixtures is completely consolidated. Hand-spade or rod the concrete if necessary to confirm flushing of mortar to the surface of all forms.

- 10. Installation of Dowels and Anchor Bolts.** Install dowels and anchor bolts by casting them in-place or by grouting with grout, epoxy, or epoxy mortar unless noted otherwise. Form or drill holes for grouting.

Drill holes for anchor bolts to accommodate the bolt embedment required by the plans. Make holes for dowels at least 12 inches deep unless otherwise shown on the plans. When using grout or epoxy mortar, make the diameter of the hole at least twice the dowel or bolt diameter, but the hole need not exceed the dowel or bolt diameter plus 1 1/2 inches. When using epoxy, make the hole diameter 1/16 to 1/4 inch greater than the dowel or bolt diameter.

Thoroughly clean holes of all loose material, oil, grease, or other bond-breaking substance, and blow them clean with filtered compressed air. Confirm that holes are in a surface dry condition when epoxy type material is used and in a surface moist condition when hydraulic cement grout is used. Develop and demonstrate for approval a procedure for cleaning and preparing the holes for installation of the dowels and anchor bolts. Completely fill the void between the hole and dowel or bolt with grouting material. Follow exactly the requirements for cleaning outlined in the product specifications for prepackaged systems.

For cast-in-place or grouted systems, provide hydraulic cement grout in accordance with Section 300.2.F, "Mortar and Grout," epoxy, epoxy mortar, or other prepackaged grouts as approved. Provide a Type III epoxy per TxDOT's DMS-6100, "Epoxy and Adhesives," when neat epoxy is used for anchor bolts or dowels. Provide Type VIII epoxy per TxDOT's DMS-6100 when an epoxy grout is used. Provide grout, epoxy, or epoxy mortar as the binding agent unless otherwise indicated on the plans.

Provide other anchor systems as required in the plans.

- 11. Placing Concrete in Cold Weather.** Protect concrete placed under weather conditions where weather may adversely affect results. Permission given by the Engineer for placing during cold weather does not relieve the Contractor of responsibility for producing concrete equal in quality to that placed under normal conditions. If concrete placed under poor conditions is unsatisfactory, remove and replace it as directed at Contractor's expense.

Do not place concrete in contact with any material coated with frost or having a temperature of 32°F or lower. Do not place concrete when the ambient temperature in the shade is below 40°F and falling unless approved. Concrete may be placed when the ambient temperature in the shade is 35°F and rising or above 40°F.

Provide and install recording thermometers, maturity meters, or other suitable temperature measuring devices to verify that all concrete is effectively protected as follows:

- Maintain the temperature of the top surface of bridge slabs and top slabs of direct-traffic culverts at 50°F or above for 72 hours from the time of placement and above 40°F for an additional 72 hours.
- Maintain the temperature at all surfaces of concrete in bents, piers, culvert walls, retaining walls, parapets, wingwalls, bottoms of bridge slab or culvert top slabs, and other similar formed concrete at 40°F or above for 72 hours from the time of placement.
- Maintain the temperature of all other concrete, including the bottom slabs (footings) of culverts, placed on or in the ground above 32°F for 72 hours from the time of placement.

Use additional covering, insulated forms, or other means and, if necessary, supplement the covering with artificial heating. Avoid applying heat directly to concrete surfaces. Cure as specified in Section 307.4.J, “Curing Concrete,” during this period until all requirements for curing have been satisfied.

When impending weather conditions indicate the possible need for temperature protection, have on hand all necessary heating and covering material, ready for use, before permission is granted to begin placement.

- 12. Placing Concrete in Hot Weather.** Use an approved retarding agent in all concrete for superstructures and top slabs of direct-traffic culverts, except concrete containing GGBF slag, when the temperature of the air is above 85°F unless otherwise directed.

Keep the concrete at or below the maximum temperature at time of placement as specified in Section 307.4.G.1, “Placing Temperature.” Sprinkle and shade aggregate stockpiles or use ice, liquid nitrogen systems, or other approved methods as necessary to control the concrete temperature.

- 13. Placing Concrete in Water.** Deposit concrete in water only when shown on the plans or with approval. Make forms or cofferdams tight enough to prevent any water current passing through the space in which the concrete is being deposited. Do not pump water during the concrete placing or until the concrete has set for at least 36 hours.

Place the concrete with a tremie or pump, or use another approved method, and do not allow it to fall freely through the water or disturb it after it is placed. Keep the concrete surface approximately level during placement.

Support the tremie or operate the pump so that it can be easily moved horizontally to cover all the work area and vertically to control the concrete flow. Submerge the lower end of the tremie or pump hose in the concrete at all times. Use continuous placing operations until the work is complete.

For concrete to be placed under water, design the concrete mix in accordance with Item 300, “Concrete,” with a minimum cement content of 650 pounds per cubic yard. Include

an anti-washout admixture in the mix design as necessary to produce a satisfactory finished product.

**14. Mass Placements.** Mass placements are defined as placements with a least dimension greater than or equal to 5 feet, or designated on the plans. For monolithic mass placements, develop and obtain approval for a plan to confirm the following during the heat dissipation period:

- the temperature differential between the central core of the placement and the exposed concrete surface does not exceed 35°F and
- the temperature at the central core of the placement does not exceed 160°F.

Base this plan on the equations given in the Portland Cement Association's Design and Control of Concrete Mixtures. Cease all mass placement operations and revise the plan as necessary if either of the above limitations is exceeded.

Include a combination of the following elements in this plan:

- selection of concrete ingredients including aggregates, gradation, and cement types, to minimize heat of hydration;
- use of ice or other concrete cooling ingredients;
- use of liquid nitrogen dosing systems;
- controlling rate or time of concrete placement;
- use of insulation or supplemental external heat to control heat loss;
- use of supplementary cementing materials; or
- use of a cooling system to control the core temperature.

Furnish and install 2 sets of temperature recording devices, maturity meters, or other approved equivalent devices at designated locations. Use these devices to simultaneously measure the temperature of the concrete at the core and the surface. Maintain temperature control methods for 4 days unless otherwise approved. Maturity meters may not be used to predict strength of mass concrete.

**15. Placing Concrete in Foundation and Substructure.** Do not place concrete in footings until the depth and character of the foundation has been inspected and permission has been given to proceed by the Engineer.

Placing of concrete footings upon seal concrete is permitted after the cofferdams are free from water and the seal concrete cleaned. Perform any necessary pumping or bailing during the concreting from a suitable sump located outside the forms.

Construct or adjust all temporary wales or braces inside cofferdams as the work proceeds to prevent unauthorized construction joints.

When footings can be placed in a dry excavation without the use of cofferdams, omit forms if approved, and fill the entire excavation with concrete to the elevation of the top of footing.

Place concrete in columns monolithically between construction joints unless otherwise directed. Columns and caps or tie beams supported on them may be placed in the same operation or separately. If placed in the same operation, allow for settlement and shrinkage of the column concrete by placing it to the lower level of the cap or tie beam, and delay placement between 1 and 2 hours before proceeding with the cap or tie beam placement.

- 16. Placing Concrete in Box Culverts.** Where the top slab and walls are placed monolithically in culverts more than 4 feet in clear height, allow between 1 and 2 hours to elapse before placing the top slab to allow for settlement and shrinkage in the wall concrete.

Accurately finish the footing slab at the proper time to provide a smooth uniform surface. Finish top slabs that carry direct-traffic as specified in this Item. Give top slabs of fill type culverts a float finish.

- 17. Placing Concrete in Superstructure.** Unless otherwise shown on the plans, place simple span bridge slabs without transverse construction joints by using either a self-propelled transverse finishing machine or a mechanical longitudinal screed. For small placements or for unusual conditions such as narrow widening, variable cross slopes, or transitions, use of manually operated screeding equipment may be permitted. Support the screed adequately on a header or rail system stable enough to withstand the longitudinal or lateral thrust of the equipment. Adjust the profile grade line as necessary to account for variations in beam camber and other factors to obtain the required slab thickness and concrete cover over the slab reinforcement. Set beams and verify their surface elevations in a sufficient number of spans so that when adjustment is necessary, the profile grade line can be adjusted over suitable increments to produce a smooth riding surface. Take dead load deflection into account in setting the grades of headers and rail systems. Use construction joints, when required or permitted for slab placements on steel or prestressed concrete beams, as shown on the plans. Before placing concrete on steel girder or truss spans, release falsework under the spans and swing the spans free on their permanent supports.

Make 1 or more passes with the screed over the bridge slab segment before placing concrete on it to confirm proper operation and maintenance of grades and clearances. Use an approved system of checking to detect any vertical movement of the forms or falsework. Maintain forms for the bottom surface of concrete slabs, girders, and overhangs to the required vertical alignment during concrete placing.

Fog unformed surfaces of slab concrete in bridge slabs and in top slabs of direct-traffic culverts from the time of initial strikeoff of the concrete until finishing is completed and required interim curing is in place. Do not use fogging as a means to add finishing water, and do not work moisture from the fog spray into the fresh concrete.

For simple spans, retard the concrete only if necessary to complete finishing operations or as required by this Section. When filling curb forms, bring the top of curb and sidewalk section to the correct camber and alignment, and finish them as described in this Item.

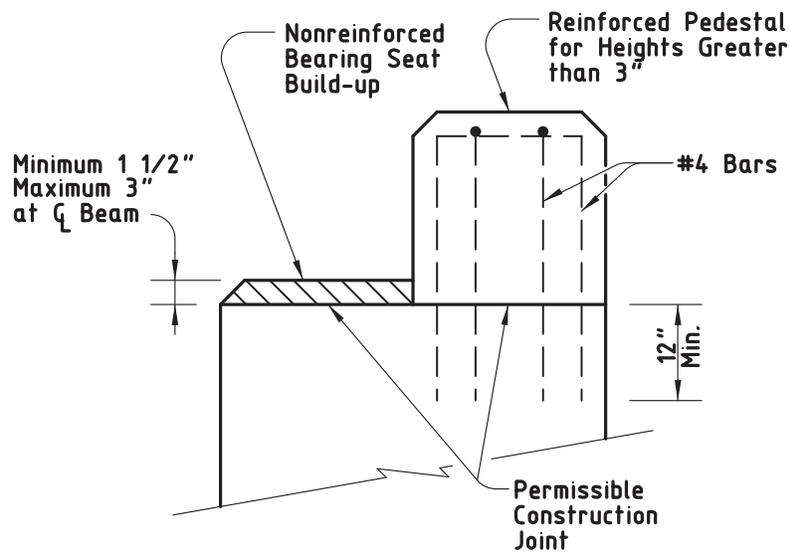
- a. Transverse Screeding.** Install rails for transverse finishing machines that are supported from the beams or girders so that the supports may be removed without damage to the slab. Prevent bonding between removable supports and the concrete in an acceptable manner. Do not allow rail support parts that remain embedded in the slab to project above the upper mat of reinforcing steel. Rail or screed supports attached to I beams or girders are subject to the requirements of this Item. Unless otherwise shown on the plans, for transverse screeding the minimum rate of concrete placement is 30 linear feet of bridge slab per hour. Deposit concrete parallel to the skew of the bridge so that all girders are loaded uniformly along their length. Deposit slab concrete between the exterior beam and the adjacent beam before placing concrete in the overhang portion of the slab. Furnish personnel and equipment capable of placing, finishing, and curing the slab at an acceptable rate to confirm compliance with the specifications. Place concrete in transverse strips. On profile grades greater than 1½%, start placement at the lowest end.
- b. Longitudinal Screeding.** Unless otherwise shown on the plans, use of temporary intermediate headers will be permitted for placements over 50 feet long if the rate of placement is rapid enough to prevent a cold joint and if these headers are designed for easy removal to permit satisfactory consolidation and finish of the concrete at their locations. Deposit slab concrete between the exterior beam and the adjacent beam before placing concrete in the overhang portion of the slab. Place concrete in longitudinal strips starting at a point in the center of the segment adjacent to 1 side except as this Section indicates, and complete the strip by placing uniformly in both directions toward the ends. For spans on a profile grade of 1½% or more, start placing at the lowest end. Use strips wide enough that the concrete within each strip remains plastic until placement of the adjacent strip. Where monolithic curb construction is specified, place the concrete in proper sequence to be monolithic with the adjacent longitudinal strips of the slabs.
- c. Placements on Continuous Steel Units.** Unless otherwise shown on the plans, place slabs on continuous steel units in a single continuous operation without transverse construction joints using a self-propelled transverse finishing machine or a mechanical longitudinal screed. Retard the initial set of the concrete sufficiently to confirm that concrete remains plastic in at least 3 spans immediately preceding the slab being placed. Use construction joints, when required for slab placements on steel beams or girders, as shown on the plans. When staged placement of a slab is required in the plans, confirm that the previously placed concrete attains a compressive strength of 3,000 psi before placing the next stage concrete. Multiple stages may be placed in a single day if approved. Where plans permit staged placing without specifying a particular order of placement, use an approved placing sequence that will not overstress of any of the supporting members.
- d. Slab and Girder Units.** Unless otherwise shown on the plans, place girders, slab, and curbs of slab and girder spans monolithically. Fill concrete girder stems first, and place the slab concrete within the time limits specified in this Item. If using a transverse screed, place concrete in the stems for a short distance and then place the concrete in transverse strips. If using a longitudinal screed, fill the outside girder stem first, beginning at the low end or side, and continue placement in longitudinal strips.

**H. Treatment and Finishing of Horizontal Surfaces Other Than Bridge Slabs.** Strike off to grade and finish all unformed upper surfaces. Do not use mortar topping for surfaces constructed under this Section.

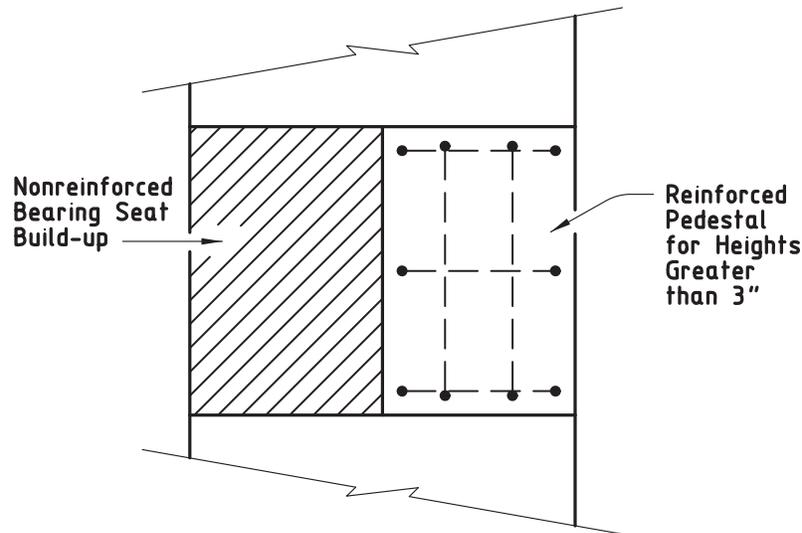
After the concrete has been struck off, float the surface with a suitable float. Give bridge sidewalks a wood float or broom finish, or stripe them with a brush.

Slightly slope the tops of caps and piers between bearing areas from the center toward the edge, and slope the tops of abutment and transition bent caps from the backwall to the edge, as directed, so that water drains from the surface. Give the concrete a smooth trowel finish. Construct bearing areas for steel units in accordance with TxDOT's Section 441.3.K.5, "Bearing and Anchorage Devices." Give the bearing area under the expansion ends of concrete slabs and slab and girder spans a steel-trowel finish to the exact grades required. Give bearing areas under elastomeric bearing pads or nonreinforced bearing seat buildups a textured, wood float finish. Do not allow the bearing area to vary from a level plane more than 1/16 inch in all directions.

Cast bearing seat buildups or pedestals for concrete units integrally with the cap or with a construction joint. Provide a latex-based mortar, an epoxy mortar, or an approved proprietary bearing mortar for bearing seat buildups cast with a construction joint. Mix mortars in accordance with the manufacturer's recommendations. Construct pedestals of Class C concrete, reinforced as shown on the plans or as indicated in Figure 1 and Figure 2.



**Figure 1**  
Section through bearing seat buildups.



**Figure 2**  
**Plan view of bearing seat buildups.**

- I. Finish of Bridge Slabs.** Provide camber for specified vertical curvature and transverse slopes.

For concrete flat slab and concrete slab and girder spans cast in place on falsework, provide additional camber to offset the initial and final deflections of the span as indicated in the plans. For concrete slab and girder spans using pan forms, provide camber of approximately 3/8 inch for 30 foot spans and 1/2 inch for 40 foot spans to offset initial and final deflections unless otherwise directed. For concrete flat slab and concrete slab and girder spans not using pan forms, when dead load deflection is not shown on the plans, provide a camber of 1/8 inch per 10 feet of span length but no more than 1/2 inch

Provide a camber of 1/4 inch in addition to deflection for slabs without vertical curvature on steel or prestressed concrete beams.

Use work bridges or other suitable facilities to perform all finishing operations and to provide access, if necessary, for the Engineer to check measurements for slab thickness and reinforcement cover.

As soon as the concrete has been placed and vibrated in a section wide enough to permit working, level, strike off, and screed the surface, carrying a slight excess of concrete ahead of the screed to fill all low spots.

Move longitudinal screeds across the concrete with a saw-like motion while their ends rest on headers or templates set true to the roadway grade or on the adjacent finished slab. Move transverse screeds longitudinally approximately 1/5 of the drum length for each complete out-and-back pass of the carriage.

Screed the surface of the concrete enough times and at intervals to produce a uniform surface true to grade and free of voids.

Work the screeded surface to a smooth finish with a long-handled wood or metal float or hand-float it from work bridges over the slab. Floating may not be necessary if the pan float attached to a transverse screed produces an acceptable finish. Avoid overworking the surface of the concrete. Avoid overuse of finish water.

Perform sufficient checks, witnessed by the Engineer, with a long-handled 16 foot straightedge on the plastic concrete to confirm that the final surface will be within specified tolerances. Make the check with the straightedge parallel to the centerline. Lap each pass half over the preceding pass. Remove all high spots, and fill and float all depressions over 1/16 inch deep with fresh concrete. Continue checking and floating until the surface is true to grade and free of depressions, high spots, voids, or rough spots. Fill screed-rail support holes with concrete, and finish them to match the top of the slab.

Finish the concrete surface to a uniform texture using a carpet drag, burlap drag, or broom finish. Finish the surface to a smooth sandy texture without blemishes, marks, or scratches deeper than 1/16 inch. Apply the surface texturing using a work bridge or platform immediately after completing the straightedge checks. Draw the carpet or burlap drag longitudinally along the concrete surface, adjusting the surface contact area or pressure to provide a satisfactory coarsely textured surface. A broom finish may be performed using a fine bristle broom transversely. For bridge approach slabs the carpet drag, burlap drag, or broom finish may be applied either longitudinally or transversely.

Coat the concrete surface immediately after the carpet or burlap drag, or broom finish with a single application of evaporation retardant at a rate recommended by the manufacturer. Do not allow more than 10 minutes to elapse between the texturing at any location and application of evaporation retardant. The evaporation retardant may be applied using the same work bridge used for surface texturing. Do not work the concrete surface once the evaporation retardant has been applied.

Apply interim and final curing in accordance with Section 307.4.J, "Curing Concrete."

The Contractor is responsible for the ride quality of the finished bridge slab. The Engineer will use a 10 foot straightedge (1/8 inch in 10 feet) to verify ride quality and to determine locations where corrections are needed. If the Engineer determines that the ride quality is unacceptable, submit a plan for approval to produce a ride of acceptable quality. Make all corrections for ride before saw-cutting grooves.

Unless noted otherwise, saw-cut grooves in the hardened concrete of bridge slabs, bridge approach slabs, and direct-traffic culverts to produce the final texturing after completion of the required curing period. Cut grooves perpendicular to the structure centerline. Cut grooves continuously across the slab to within 18 inches of the barrier rail, curb, or median divider. At skewed metal expansion joints in bridge slabs, adjust groove cutting by using narrow-width cutting heads so that all grooves end within 6 inches of the joint, measured perpendicular to the centerline of the metal joint. Leave no ungrooved surface wider than 6 inches adjacent to either side of the joint. Confirm that the minimum distance to the first groove, measured perpendicular to the edge of the concrete joint or from the junction between the concrete and the metal leg of the joint, is 1 inch. Cut grooves continuously across construction joints or other joints in the concrete that are less than 1/2 inch wide. Apply the same procedure described above where barrier rails, curbs, or median dividers are not parallel to the structure centerline to maintain the 18 inches maximum dimension from the end of the grooves to the gutter line. Cut grooves continuously across formed concrete joints.

When saw-cut grooves are not required in the plans, provide either a carpet drag or broom finish for micro-texture. In this case insure that an adequate and consistent micro-texture is achieved by applying sufficient weight to the carpet and keeping the carpet or broom from getting plugged with grout. For surfaces that do not have adequate texture, the Engineer may require corrective action including diamond grinding or shot blasting.

When the plans call for a concrete overlay to be placed on the slab (new construction) or on prestressed concrete box beams or other precast elements, give a carpet drag, burlap drag, or broom finish to all concrete surfaces to be overlaid. Saw-grooving is not required in this case. Provide an average texture depth for the finish of approximately 0.035 inch with no individual test falling below 0.020 inch, unless otherwise shown on the plans, when tested in accordance with TxDOT standard laboratory test procedure Tex-436 A. If the texture depth falls below what is intended, revise finishing procedures to produce the desired texture.

When the plans require an asphalt seal, with or without overlay, on the slab (new construction), on prestressed concrete box beams, or on other precast elements, give all concrete surfaces to be covered a lightly textured broom or carpet drag finish. Provide an average texture depth of approximately 0.025 inch when tested in accordance with TxDOT standard laboratory test procedure Tex-436-A.

- J. Curing Concrete.** Obtain approval of the proposed curing methods, equipment, and materials before placing concrete. The Engineer may require the same curing methods for like portions of a single structure. Inadequate curing or facilities may delay all concrete placement on the job until remedial action is taken.

A curing day is a calendar day when the temperature, taken in the shade away from artificial heat, is above 50°F for at least 19 hours or, on colder days if the temperature of all surfaces of the concrete is maintained above 40°F, for the entire 24 hours. The required curing period begins when all concrete has attained its initial set. TxDOT standard laboratory test procedure Tex-440-A may be used to determine when the concrete has attained its initial set.

Cure all concrete for 4 consecutive days except as noted in Table 1.

**Table 1**  
**Exceptions to 4-Day Curing**

Description	Type of Cement	Required Curing Days
Upper surfaces of bridge slabs, top slab of direct-traffic culverts, and concrete overlays	I or III	8
	II or I/II	10
	All types with supplementary cementing materials	10
Concrete piling buildups	All	6

For upper surfaces of bridge slabs, bridge approach slabs, median and sidewalk slabs, and culvert top slabs constructed using Class S concrete, apply interim curing using a Type 1-D curing compound before the water sheen disappears but no more than 45 minutes after application of the evaporation retardant. Do not allow the concrete surface to dry before applying the interim cure, and do not place the interim cure over standing water. Apply membrane interim curing using a work bridge or other approved apparatus to confirm a uniform application. Water-cure for final curing in accordance with this Section, starting as soon as possible without damaging the surface finish. Maintain the water curing for the duration noted in Table 1. Place polyethylene sheeting, burlap-polyethylene blankets,

laminated mats, or insulating curing mats in direct contact with the slab when the air temperature is expected to drop below 40°F during the first 72 hours of the curing period. Weigh down these curing materials with dry mats to maintain direct contact with the concrete and to provide insulation against cold weather. Supplemental heating or insulation may be required in cold and wet weather if the insulating cotton mats become wet or if the concrete drops below the specified curing temperature. Avoid applying heat directly to concrete surfaces.

For the top surface of any concrete unit upon which concrete is to be placed and bonded at a later interval (stub walls, risers, etc.) and other superstructure concrete (curbs, wingwalls, parapet walls, etc.), use only water curing in accordance with this Section.

Cure all other concrete as specified in the pertinent Items. Use the following methods for curing concrete, subject to the requirements of this Item.

1. **Form Curing.** When forms are left in intimate contact with the concrete, other curing methods are not required except for exposed surfaces and for cold weather protection. If forms are removed before the 4 day required curing period, use another approved curing method.
2. **Water Curing.** Keep all exposed surfaces of the concrete wet continuously for the required curing time. Use water curing that meets the requirements for concrete mixing water in Section 300.2.D, "Water." Do not use seawater or water that stains or leaves an unsightly residue.
  - a. **Wet Mats.** Keep the concrete continuously wet by maintaining wet cotton mats in direct contact with the concrete for the required curing time. If needed, place damp burlap blankets made from 9 ounce stock on the damp concrete surface for temporary protection before applying cotton mats. Then place the dry mats and wet them immediately after they are placed. Weight the mats adequately to provide continuous contact with all concrete. Cover surfaces that cannot be cured by direct contact with mats, forming an enclosure well anchored to the forms or ground so that outside air cannot enter the enclosure. Provide sufficient moisture inside the enclosure to keep all surfaces of the concrete wet.
  - b. **Water Spray.** Overlap sprays or sprinklers to keep all unformed surfaces continuously wet.
  - c. **Ponding.** Cover the surfaces with at least 2 inches of clean granular material, kept wet at all times, or at least 1 inch deep water. Use a dam to retain the water or saturated granular material.
3. **Membrane Curing.** Unless otherwise shown on the plans, choose either Type 1-D or Type 2 membrane-curing compound when membrane curing is permitted. Type 1-D (Resin Base Only) is required for interim curing bridge slabs and top slabs of direct-traffic culverts and all other surfaces that require a higher grade of surface finish. For substructure concrete provide only 1 type of curing compound on any 1 structure.

Apply membrane curing just after free moisture has disappeared at a rate of approximately 180 square feet per gallon. Do not spray curing compound on projecting reinforcing steel or concrete that will later form a construction joint. Do not apply

membrane curing to dry surfaces. Dampen formed surfaces and surfaces that have been given a first rub so that they are moist at the time of application of the membrane.

When membrane is used for complete curing, leave the film unbroken for the minimum curing period specified. Correct damaged membrane immediately by reapplication of membrane. Polyethylene sheeting, burlap-polyethylene mats, or laminated mats in close contact with the concrete surfaces are equivalent to membrane curing.

- K. Removal of Forms and Falsework.** Unless otherwise directed, forms for vertical surfaces may be removed after the concrete has aged 12 hours after initial set provided the removal can be done without damage to the concrete. Keep forms for mass placements, defined in Section 307.4.G.14, "Mass Placements," in place for 4 days following concrete placement.

Remove forms for inside curb faces and for bridge rails whenever removal can be done without damage to the curb or railing.

Leave in place weight-supporting forms and falsework spanning more than 1 foot for all bridge components and culvert slabs except as directed otherwise until the concrete has attained a compressive strength of 2,500 psi. Remove forms for other structural components as necessary.

Remove inside forms (walls and top slabs) for box culverts and sewers after concrete has attained a compressive strength of 1,800 psi if an approved overhead support system is used to transfer the weight of the top slab to the walls of the box culvert or sewer before removal of the support provided by the forms.

Forms or parts of forms may be removed only if constructed to permit removal without disturbing forms or falsework required to be left in place for a longer period on other portions of the structure.

Remove all metal appliances used inside forms for alignment to a depth of at least 1/2 inch from the concrete surface. Make the appliances so that metal may be removed without undue chipping or spalling of the concrete, and so that it leaves a smooth opening in the concrete surface when removed. Do not burn off rods, bolts, or ties.

Remove all forms and falsework unless otherwise directed.

- L. Defective Work.** Repair defective work as soon as possible. Remove and replace at the expense of the Contractor any defect that cannot be repaired to the satisfaction of the Engineer.

- M. Ordinary Surface Finish.** Apply an ordinary surface finish to all concrete surfaces as follows:

- Chip away all loose or broken material to sound concrete where porous, spalled, or honeycombed areas are visible after form removal.
- Repair spalls by saw-cutting and chipping at least 1/2 inch deep, perpendicular to the surface to eliminate feather edges. Repair shallow cavities using a latex adhesive grout, cement mortar, or epoxy mortar as approved. Repair large areas using concrete as directed or approved.

- Clean and fill holes or spalls caused by the removal of form ties, etc., with latex grout, cement grout, or epoxy grout as approved. Fill only the holes. Do not blend the patch with the surrounding concrete. On surfaces to receive a rub finish in accordance with Item 311, "Concrete Surface Finish," chip out exposed parts of metal chairs to a depth of 1/2 inch and repair the surface.
- Remove all fins, runs, drips, or mortar from surfaces that will be exposed. Smooth all form marks and chamfer edges by grinding or dry-rubbing.
- Confirm that all repairs are dense, well bonded, and properly cured. Finish exposed large repairs to blend with the surrounding concrete where a higher class of finish is not specified.

Unless noted otherwise, apply an ordinary surface finish as the final finish to the following exposed surfaces:

- inside and top of inlets,
- inside and top of manholes,
- inside of sewer appurtenances,
- inside of culvert barrels,
- bottom of bridge slabs between girders or beams, and
- vertical and bottom surfaces of interior concrete beams or girders.

Form marks and chamfer edges do not need to be smoothed for the inside of culvert barrels and the bottom of bridge slabs between girders or beams.

**307.5. MEASUREMENT:** This Item will be measured by the cubic yard, square yard, foot, square foot, or by each structure.

**A. General.** Concrete quantities will be based on the dimensions shown on the plans or those established in writing by the Engineer.

In determining quantities, no deductions will be made for chamfers less than 2 inches or for embedded portions of steel or prestressed concrete beams, piling, anchor bolts, reinforcing steel, drains, weep holes, junction boxes, electrical or telephone conduit, ducts and voids for prestressed tendons, or embedded portions of light fixtures.

For slab and girder spans using pan forms, a quantity will be included for the screed setting required to provide proper camber in the roadway surface after form removal.

For slabs on steel or prestressed concrete beams, an estimated quantity for the haunch between the slab and beams will be included. No measurement will be made during construction for variation in the amount of haunch concrete due to variations in camber of the beams.

For cast-in-place slabs on slab beams, double T beams, or box beams, the combination of span length, theoretical camber in beams, computed deflections, and plan vertical curve will be taken into account in determining the quantity for the slab.

Additional concrete that may be required by an adjustment of the profile grade line during construction, to insure proper slab thickness, will not be measured for payment.

Variation in concrete headwall quantity incurred when an alternate bid for pipe is permitted will not be cause for payment adjustment.

Mass placements may be either a plans quantity item or measured in place as indicated.

Quantities revised by a change in design, measured as specified, will be increased or decreased and included for payment.

- B. Plans Quantity.** Structure elements designated in Table 2 and measured by the cubic yard are plans quantity measurement items. The quantity to be paid for plans quantity items is the quantity shown in the proposal unless modified by TxDOT's Article 9.2, "Plans Quantity Measurement." Additional measurements or calculations will be made if adjustments of quantities are required.

No adjustment will be made for footings or other in-ground elements where the Contractor has been allowed to place concrete in an excavation without forms.

**Table 2**  
**Plans Quantity Payment**  
**(Cubic Yard Measurement Only)**

Culverts and culvert wing walls	Abutments
Headwalls for pipe	Slab and girder spans (pan form)
Retaining walls	Footings
Inlets and manholes	Pile bent caps
Shear key concrete for box and slab beams	Concrete wearing surface on pre-cast box beams, slab beams or double-T beams
Bridge approach slabs	Cast-in-place concrete slab spans

Note: Other structure elements, including pier and bent concrete, may be paid for as "plans quantity" when shown on the plans.

- C. Measured in Place.** Items not paid for as "plans quantity" will be measured in place.

- 307.6. PAYMENT:** The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for the various structure elements specified of the various classes of concrete. Mass placements, as defined in Section 307.4.G.14, "Mass Placements," will be paid for separately for the various classes of concrete. This price is full compensation for furnishing, hauling, and mixing concrete materials; furnishing, bending, fabricating, splicing, welding and placing the required reinforcement; clips, blocks, metal spacers, ties, wire, or other materials used for fastening reinforcement in place; placing, finishing, curing, and grooving concrete; applying ordinary surface finish; furnishing and placing drains, metal flashing strips, and expansion-joint material; excavation, subgrade preparation, and disposal of excavated material for bridge approach slabs; and forms and falsework, equipment, labor, tools, and incidentals.

Diaphragm concrete will not be paid for directly but is subsidiary to the slab unless otherwise shown on the plans.

Design and installation of foundations for falsework is at the Contractor's expense.

The following procedure will be used to evaluate concrete where 1 or more project acceptance test specimens fail to meet the required design strength specified in Item 300, "Concrete," or in the plans:

- The concrete for a given placement will be considered structurally adequate and accepted at full price if the average of all test results for specimens made at the time of placement meets the required design strength provided that no single test result is less than 85% of the required design strength.
- The Engineer will perform a structural review of the concrete to determine its adequacy to remain in service if the average of all test results for specimens made at the time of placement is less than the required design strength or if any test results are less than 85% of the required design strength. If cores are required to determine the strength of the in-situ concrete, take cores at locations designated by the Engineer in accordance with TxDOT standard laboratory test procedure Tex-424-A. The coring and testing of the cores will be at the Contractor's expense. The Engineer will test the cores.
- If all of the tested cores meet the required design strength, the concrete will be paid for at the full price.
- If any of the tested cores do not meet the required design strength but the average strength attained is determined to be structurally adequate, the Engineer will determine the limits of the pay adjustment. The average strength of the cores tested will be used in the pay adjustment formula.
- Remove concrete that is not structurally adequate.
- Concrete that has been determined to be structurally adequate may be accepted at an adjusted price based on the following formula:

$$A = B_p[-5.37(S_a/S_s)^2 + 11.69(S_a/S_s) - 5.32]$$

Where:

A = Amount to be paid

S<sub>a</sub> = Actual strength from cylinders or cores

S<sub>s</sub> = Specified design strength

B<sub>p</sub> = Unit bid price

- The decision to reject structurally inadequate concrete or to apply the pay adjustment will be made no later than 56 days after placement.

### 307.7. BID ITEM:

N/A

N/A

**ITEM****311 CONCRETE SURFACE FINISH**

**311.1. DESCRIPTION:** *Finish concrete surface as specified.*

**311.2. MATERIALS:** Furnish materials in accordance with this Article for the type of surface finish specified.

**A. Coatings.**

- 1. Adhesive Grout and Concrete Paint.** Provide coatings in accordance with TxDOT's DMS 8110, "Coatings for Concrete." Match color of coating with Federal Standard 595B color 35630, concrete gray, unless otherwise shown on the plans.
- 2. Opaque Sealer.** Provide penetrating-type sealer in accordance with TxDOT's DMS 8110, "Coatings for Concrete." Match color of coating with Federal Standard 595B color 35630, concrete gray, unless otherwise shown on the plans.
- 3. 742 Appearance Coating.** Provide #742 gray appearance coating (Federal Standard 595B color 35630) in accordance with TxDOT's DMS 8100, "Structural Steel Paints-Formula."
- 4. Epoxy Paint.** Provide Type X epoxy coating in accordance with TxDOT's DMS 6100, "Epoxies and Adhesives."

**B. Exposed Aggregate Finish.** Provide approved aggregates meeting the grading requirements shown on the plans. Unless otherwise shown on the plans, provide gravel consisting of predominantly rounded particles. When a bush-hammered finish is desired, use crushed stone. Provide a concrete surface retardant. Provide clear acrylic resin sealer in accordance with TxDOT's DMS 8110, "Coatings for Concrete," or clear Type II permanent anti-graffiti coating in accordance with TxDOT's DMS 8111, "Anti-Graffiti Coatings."

**311.3. EQUIPMENT:** The Engineer may require demonstration of the equipment's capabilities.

- A. Low-Pressure Water Blasting.** Use equipment capable of supplying a minimum pressure at the nozzle end of 3,000 psi at a minimum flow rate of 3 gpm. Use a 0° rotary, vibratory, or wobble-type nozzle. Use equipment capable of including abrasives in the water stream when specified on the plans.
- B. Abrasive Blasting.** Use equipment equipped with filters to produce oil-free air and also water-free air when dry air is required.
- C. Slurry Blasting.** Use equipment capable of combining air and abrasives with water to form a wet blast media capable of cleaning and preparing surface without creating dust.
- D. Spraying.** For spray applications, use equipment with fluid and air pressure regulators and gauges to allow for adjustment to produce a uniform spray pattern.
- E. Off-the-Form Finish Forms.** Use non-staining, nonporous, high-quality forming materials (e.g., steel or medium-density and high-density overlaid plywood forms). Use steel or high-density overlaid plywood forms when the same form will be used more than twice.

- F. Form Liners.** Provide form liners capable of producing a patterned finish as shown on the plans. Use form liners that provide a clean release from the concrete surface without pulling or breaking the textured concrete.

**311.4. CONSTRUCTION:** Provide the finish specified on the plans for the specific surface areas.

- A. Surface Areas of Finish.** “Surface area of finish” designates the areas where the specified surface is to be applied.

**1. Surface Area I.** Surface Area I includes:

- surfaces of railing;
- exterior vertical faces of fascia beams, slabs, slab spans, arches, and box girders;
- the outside bottom surface of fascia beams and girders;
- the underside of overhanging slabs to the point of juncture of the supporting beam;
- the entire underside of slab spans when shown on the plans;
- vertical and underside surfaces of bents and piers;
- all surfaces of tie beams, abutments, bridge wingwalls, culvert headwalls and wingwalls and retaining walls exposed to view after all backfill and embankment is placed; and
- all other exposed surfaces shown in the plans to require surface treatment.

**2. Surface Area II.** Surface Area II includes surfaces of railing, all wingwalls, and the exterior vertical faces of slabs.

**3. Surface Area III.** Surface Area III includes only the top and roadway faces of all concrete railing and bridge wingwalls.

**4. Surface Area IV.** Surface Area IV includes areas designated on the plans.

- B. Surface Finishes.** Apply the coating or special finish from Table 1 as specified on the plans.

**Table 1**  
**Surface Finishes**

<b>Coatings</b>	<b>Special Surface Finishes</b>
Adhesive grout	Blast
Concrete paint	Rub
Opaque sealer	Off-the-form
742 appearance coating	Form liner
Epoxy paint	Exposed aggregate

**1. Application of Coatings.**

- a. Preparation.** Before applying a coating, thoroughly clean the surface by chemical cleaning, if required, and by blast cleaning.

**(1) Chemical Cleaning.** Clean surfaces contaminated with oil, grease, or other contaminants by scrubbing the area with an approved detergent or other concrete cleaning material before blast cleaning. Do not use a solvent that will stain the surface or inhibit coating adhesion. Perform the following test to check for surface contamination of oil type materials:

- Spray the surface with a fine mist of potable water.
- Examine the area to see if water beads up.
- If beading is found, clean the surface.

**(2) Blast Cleaning.** Before applying a specified coating, blast-clean the designated surface to remove weak surface material, curing compound, and other contaminants, leaving a lightly etched uniformly textured surface. Use an approved abrasive propelled by oil-free air with or without the addition of potable water, or blast with potable water with or without the addition of an approved abrasive at sufficient pressure to effectively clean and prepare the surface. When water-blasting, maintain the stand-off-distance of the nozzle to a maximum of 12-inches from the surface being cleaned.

Do not damage concrete surface by gouging, spalling, or exposing coarse aggregate by the blasting operation.

Immediately before application of any coating, blow clean oil- and moisture-free air on all surfaces with sufficient pressure to remove loose particles. Perform the following test to check for surface cleanliness as directed:

- Press a 10-inch long strip of 2-inches wide clear packing tape on the surface by rubbing with moderate pressure times.
- Grasp the free end of the tape, and remove the tape from the surface with a sharp jerk.
- Examine the surface of the tape for clinging particles.

Continue cleaning the concrete surface until there are no particles clinging to the tape surface for subsequent tests. An additional test that can be used to check the surface for dust is to wipe the surface with a dark cloth and then examine the cloth for discoloration.

**b. Application.** Mix coating materials thoroughly with a mechanical mixer at a speed that causes the mixture to rotate entirely in the container. Ensure complete mixing by probing the container with a stirring device searching for non-dispersed or settled material.

Do not apply coatings before the new concrete aging a minimum of 28-days unless approved otherwise. Do not apply coatings when weather conditions will be detrimental to the final surface finish as determined by the Engineer. Do not apply coatings when surface temperature of the concrete exceeds 110°F.

Apply coatings to obtain a consistent color and texture.

- (1) **Adhesive Grout.** Apply coating on a moistened surface to a uniform minimum thickness of 1/16-inch. Do not apply when ambient temperature is less than 50°F.
- (2) **Concrete Paint.** Apply the coating on a dry surface in 2 coats for a total maximum application rate of 150 square feet per gallon. Match the color of the applied coating with the color standard shown on the plans. Do not thin material unless approved. Apply when ambient temperature is between 50°F and 100°F.
- (3) **Opaque Sealer.** Apply the coating to a dry surface in 2 coats for a total maximum application rate of 200 square feet per gallon. Match the color of the applied coating with the approved color standard shown on the plans. Do not thin the material unless approved. Apply when ambient temperature is between 40°F and 95°F.
- (4) **742 Appearance Coating.** Apply the coating on a dry surface at a rate of at most 400 square feet per gallon. Apply when ambient temperature is above 40°F.
- (5) **Epoxy Paint.** Apply the coating on a dry surface at a maximum application rate of 100 square feet per gallon. Apply when ambient temperature is above 50°F.

Repair surface finish where coating has been applied that exhibits peeling, flaking, or discoloration or that has been damaged during construction. Remove defective or damaged coating. Clean and recoat repair area in accordance with the requirements of this Item.

2. **Special Surface Finishes.** Submit a work plan to the Engineer for any special finish shown on the plans. Include in the work plan the type of aggregates, materials, variation of panel or pattern arrangement, dimensions, construction methods, and other features affecting the work as is necessary for the “Special Surface Finish” specified.
  - a. **Blast Finish.** Provide surface profile as shown in the plans, or meet the minimum requirements of Section 311.4.B.1.a, “Preparation.” Construct a 4 feet by 4 feet sample panel using the same concrete used in construction of the member to receive the blast finish. Prepare the surface of the sample panel to meet the specified finish, and obtain approval of the sample finish. Use the approved sample panel finish as the standard for surfaces requiring a blast finish.
  - b. **Rub Finish.** Provide a finish to the surface by rubbing the surface with a carborundum stone or other approved material. Begin rubbing the surface immediately after forms have been removed. If rubbing surface is delayed to the point where the surface is dry and unable to be rubbed to produce an acceptable finish, provide blast finish or other finish as directed at no additional cost to the City. Perform the requirements to obtain the ordinary surface finish specified in Section 307.4.M, “Ordinary Surface Finish,” concurrently with rubbing the surface. Where concrete patching is performed, rub these areas after the patch material has thoroughly set and blend the patch in with the surrounding area to produce a surface with uniform color and texture.

After form removal, keep the surface continuously wet until the rubbing is complete. Rub the surface sufficiently to bring the wetted concrete surface to a paste producing a smooth dense surface without pits, form marks, or other irregularities. Do not use

cement grout to form the paste on the surface. Stripe the surface with a brush to conceal the rubbing pattern and allow the paste to reset. Wash the concrete with potable water after the paste has sufficiently set to leave it with a neat and uniform appearance and texture. If required, apply membrane curing in accordance with Item 307, "Concrete Structures," after rubbing is complete.

- c. **Off-the-Form Finish.** Provide a finish with minimal surface defects and uniform color and texture by using non-staining, non-porous, high-quality forming materials. Use the same type of forming materials for like elements for the entire structure.

Use mortar-tight forms to prevent leakage and discoloration. If necessary, seal joints with compressible gasket material, caulk, tape or by other suitable means that are not detrimental to the concrete finish. Use one brand and type of form release agents for all surfaces unless another product produces a similar concrete surface appearance. Do not use barrier-type (wax, fuel oil, carrier oil, etc.) release agents. Use form release agents containing a rust inhibitor on steel forms. Clean rust off steel forms before use. Do not use plywood that will cause discoloration of the concrete surface.

Direct special attention to consolidation and vibration of the concrete around the form surfaces to minimize bug holes. Modify concrete placement and vibration techniques if surface contains an excessive amount of bug holes. Remove all forms without interruption once form removal begins to prevent discoloration due to differing form curing times.

Do not use membrane curing on surfaces with off-the-form finish.

Repair honeycombed and spall areas with least dimension larger than 2-inches in accordance with the concrete surface repair procedures outlined in Item 307, "Concrete Structures," to obtain an ordinary surface finish as defined in Section 307.4.M, "Ordinary Surface Finish." For honeycombed and spall areas with least dimension greater than  $\frac{3}{4}$ -inch but smaller than 2-inches, patch by filling defect with repair material omitting the chipping operation. Do not patch honeycombed and spall areas with least dimension smaller than  $\frac{3}{4}$ -inch. Perform required repairs as soon as forms are removed. Match repair material color and texture with surrounding concrete surfaces. Minimize the area of repair by not smearing the repair material over acceptable concrete surfaces in an attempt to blend the repair with the surrounding concrete. Cut out form ties at least  $\frac{1}{2}$ -inch below the surface, and patch accordingly. Perform repair work as soon as possible after removing forms so that concrete and repair material have similar ages. Replace or refurbish the forms when the Engineer determines that defective formwork is causing an excessive amount of repair work.

- d. **Form Liner Finish.** Provide patterned finish as shown on the plans. Do not splice form liner panels in a way that causes a noticeable transition or line between pieces. Wash and clean form liners after each use when the forms can be re-used. Replace form liners that have become damaged or worn.

Construct a sample panel for each form liner finish. Approval is required to verify that the sample panel meets the requirements of the plans and specifications before beginning work. Upon approval, the sample panel becomes the model panel that all other work will be compared against. Deviation in color, grade, or depth from the model panel is grounds for rejection of the form liner finish. Removal of defective

work may be necessary as determined by the Engineer and in accordance with the surface finish requirements outlined in Item 307, "Concrete Structures," to obtain an ordinary surface finish as defined in Section 307.4.M, "Ordinary Surface Finish."

Seal all form liner joints in a manner acceptable to the Engineer to prevent leakage at the surface.

- e. **Exposed Aggregate Finish.** Provide exposed aggregate finish as indicated on the plans. Provide a depth of finish between 3/8-inch and 1/2-inch unless directed otherwise.

Apply a concrete surface retarder that penetrates approximately 1/4-inch into the forms or concrete surface to help achieve the desired finish. Apply 2 or 3 coats to wood forms to account for absorption if necessary. Tape or caulk form joints to prevent escape of the retarder during the placing operations. Protect the form surfaces from sun and rain while exposed to the atmosphere. Re-treat form surfaces with retarder if disturbed. Protect adjacent areas of concrete not requiring exposed aggregate finish from the retarder.

Remove forms 12 to 15 hours after concrete placement but not before concrete has gained sufficient strength to support the self-weight of the member unless directed otherwise. Expose the aggregate for the finish immediately after form removal. Remove the grout paste covering the aggregate to be exposed by an approved method. Do not loosen the aggregate by the grout removal operation. Maintain required curing on all surfaces except for the time while the aggregate is being exposed. Cure using wet mats or membrane after the aggregate is exposed.

Repair defective areas as determined by the Engineer.

Re-clean exposed aggregate surfaces by an approved method. Apply a coat of acrylic resin sealer or clear Type II permanent anti-graffiti coating to cleaned exposed aggregate surface. Apply a single coat or multiple coats for a total maximum application rate of 250 square feet per gallon.

- 311.5. MEASUREMENT:** When surface finishes for concrete is shown on the plans to be a pay item, measurement will be by the square foot of the type of surface finish specified.

This is a plans quantity measurement Item. The quantity to be paid is the quantity shown in the proposal, unless modified by TxDOT's Article 9.2, "Plans Quantity Measurement." Additional measurement or calculations will be made if adjustments of quantities are required.

- 311.6. PAYMENT:** Unless otherwise specified on the plans, the work performed, materials furnished, equipment, labor, tools, and incidentals will not be paid for directly, but will be considered subsidiary to pertinent Items.

When a surface finish for concrete is specified as a pay item, the work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Adhesive Grout Finish," "Concrete Paint Finish," "Opaque Sealer Finish," "742 Appearance Coating Finish," "Epoxy Paint Finish," "Blast Finish," or "Rub Finish." This price is full compensation for materials; cleaning and preparing surfaces; application of materials; and equipment, labor, tools, and incidentals.

Off-the-form, form liner, or exposed aggregate finishes (including anti-graffiti coating) will not be paid for under this Item but are subsidiary to other pertinent Items.

**311.7. BID ITEM:**

N/A

## DIVISION IV - STORM SEWERS

### ITEM

#### 400 EXCAVATION, TRENCHING AND BACKFILLING

**400.1. DESCRIPTION:** *Excavate, trench, and backfill storm drainage pipe, and pipe culverts, unless otherwise noted on the plans, details and the specifications. The work shall include all necessary pumping or bailing, sheeting, drainage and the construction and removal of any required cofferdams. All existing utilities shall be protected from damage during the excavation and backfilling of trenches, and if damaged, shall be replaced or repaired by the Contractor at his expense. Unless otherwise shown on the plans and bid proposal all excavation shall be unclassified, and shall include all materials encountered regardless of their nature or the manner in which they are removed.*

**400.2. MATERIALS:** Use materials that meet the requirements of the following Items:

- A. Aggregate.** Item 200, "Flexible Base."
- B. Gravel.** Item 410, "Subgrade Filler."
- C. Cement Stabilized Sand.** Item 412, "Cement Stabilized Sand."
- D. Glass Cullet.** Item 411, "Glass Cullet use for Utility Bedding and Backfill."
- E. Flowable Fill.** Item 413, "Flowable Fill."
- F. Filter Fabric.** TxDOT DMS 6200, "Filter Fabric," Type1.

**400.3. CONSTRUCTION:**

**A. Excavation.**

- 1. General.** The Contractor shall perform all excavation of every description and of whatever substances encountered, to the lines and grades shown on the plans or determined by the Engineer. Unless otherwise indicated, excavation shall be by open cut except that short sections may be tunneled, if in the opinion of the Engineer, the pipe or structure can be safely and properly installed or constructed, and backfill can be properly tamped in such tunnel sections.
- 2. Safety.** Provide slopes, benching, sheeting, bracing, pumping, and bailing as necessary to maintain the stability and safety of excavations. Excavation protection is governed by Item 550, "Trench Excavation Safety Protection," and Item 551, "Special Shoring."
- 3. Excavated Materials.** During excavation, material suitable for backfilling shall be stockpiled in an orderly manner a sufficient distance from the banks of the trench to avoid overloading and to prevent slides or cave-ins. All excavated materials not required or not suitable for backfill shall be removed and properly disposed of by the Contractor or as directed by the Engineer. Proper disposal shall be in conformance with, but not limited to, the following provisions:
  - a.** Do not deposit excavated material within jurisdictional wetlands, and



Do not pump or bail while placing structural concrete or for a period of at least 36 hr. thereafter unless from a suitable sump separated from the concrete work. Pump or bail during placement of seal concrete only to the extent necessary to maintain a static head of water within the cofferdam. Do not pump or bail to de-water inside a sealed cofferdam until the seal has aged at least 36 hours.

If the bottom of an excavation cannot be de-watered to the point that the subgrade is free of mud or it is difficult to keep reinforcing steel clean, place a stabilizing material in the bottom of the excavation. Stabilizing material may be controlled low strength material, flowable backfill, or other material approved by the Engineer. Stabilizing material placed for the convenience of the Contractor will be at the Contractor's expense.

## **B. Trenching.**

1. **General.** Trench walls shall be vertical in excavations through stable rock, as classified and substantiated during construction by a competent professional as defined by OSHA, and the practice of undercutting at the bottom or flaring at the top will not be permitted unless approved by the Engineer. In special cases where trench flaring is permitted and directed by the Engineer, the trench walls shall remain vertical to a depth of at least 1 foot above the top of the pipe. The bottom of the trenches shall be accurately graded to provide uniform bearing and support for each section of pipe on the undisturbed soil at every point along its entire length, except for the portions of pipe sections where it is necessary for bells and for the proper sealing of pipe joints. Bell holes and depressions for joints shall be dug after the trench bottom has been graded in order that the pipe may rest upon the prepared bottom for as much of its full length as practicable.
2. **Depth of Cut.** The depth of cut shall be measured from the offset or cut hub elevation to the invert of the pipe and shall be determined by the Contractor. The width of the trench shall be at least the outside diameter of the pipe plus 6 inches on each side of the pipe for pipe sizes less than 42 inches in diameter.

It shall be understood that the depth of cut as initially indicated may be more or less than the actual excavated depth due to ground conditions existing at the site. For this reason the Engineer shall determine the depth for pay purposes based on the surface elevation prior to the Contractor's operation and the invert of the sewer line. The Engineer's decision shall be final.

3. **Working Space.** The maximum working room for pipe 42 inches in diameter and under shall not exceed  $\frac{1}{2}$  of the outside diameter of the pipe or 12 inches whichever is greater, from the edge of the pipe to the face of the trench walls, or inside face of the shoring protection.

For pipe over 42 inches in diameter the maximum width of the trench shall be such that the working space from the pipe to the trench wall, or shoring protection as the case may be, will be a minimum of 12 inches, and a maximum of 24 inches. If allowable trench widths are exceeded through over-shooting of rock, caving of earth trenches or over-excavation, the Contractor shall employ corrective measures or alternative designs as determined by the Engineer.

**C. Over Excavation.**

1. **Unstable Material.** Whenever wet or otherwise unstable soil that is incapable of properly supporting the structure or pipe, as determined by the Engineer, is encountered in the bottom of the excavation or trench, such soil shall be removed to the depth shown on the plans or determined by the Engineer and the excavation or trench backfilled to the proper grade with a gravel subgrade filler as specified in Item No. 410, "Subgrade Filler" or other suitable bedding material.
2. **Incompressible Material.** Where trash, debris, rock, boulder or coarse gravel with a particle size larger than 1 ¾ inch is encountered at the bearing level, the Contractor shall, as directed by the Inspector, over-excavate and remove such materials to a depth not less than 4 inches below the bottom of the pipe and replace with a gravel material conforming to the requirements of Item 410, "Subgrade Filler" or other suitable bedding material.
3. **Unauthorized Excessive Excavation.** Whenever over-excavation occurs that is not a result of unstable or incompressible material as defined above, the under-cut trench shall be restored to grade, to the satisfaction of the Inspector, by replacement of excavated material compacted to the same density as the surrounding natural ground.

**D. Bedding.** When bedding material is required by the plans, place the material to the depth specified and in the manner described herein.

1. Bedding material may consist of lean clay, gravel, clean sand, cement stabilized sand, glass cullet that conforms to the requirements of Item 411, "Glass Cullet use for Utility Bedding and Backfill," or other materials approved by the Engineer.
2. Remove loose, sloughing, or caving soil from the bottom and sidewall of trenches immediately prior to placement of bedding materials. Place bedding to the depths shown on the Standard Details or project plans.
3. For pipe installation, manually spread bedding materials around pipe to provide uniform bearing and side support when compacted. Protect flexible pipe from damage during placing of pipe zone bedding material. Perform placement and compaction directly against undisturbed soils in trench sidewalls, or against sheeting which is to remain in place.
4. Do not place trench shields or shoring within the height of the bedding zone unless means to maintain density of compacted bedding material are used. If moveable supports are used in the bedding zone, lift supports incrementally to allow placement and compaction of material against undisturbed soil.
5. If shown on the plans or directed by the Engineer, place geotextile on the bottom of the excavated trench prior to the placement of any sand, glass cullet, or granular bedding to prevent particle migration from in-situ soil into open-graded bedding materials or drainage layers, when used.
6. Compact bedding material to its specific compaction requirements using pneumatic tampers in restricted areas, and vibratory-plate compactors or engine-powered jumping jacks in unrestricted areas. Compact each lift before proceeding with placement of next lift. Water tamping is not allowed.

**E. Backfilling.**

1. **General.** Trench shall not be backfilled until the constructed structures or appurtenances as installed conform to the requirements specified. The trench shall be carefully backfilled with the materials approved for backfilling as described in 400.3.E.2. "Pipe Backfilling" or other materials approved by the Engineer.

Where pipe is specially coated for protection against corrosion, care shall be taken not to damage the coating.

Any trench improperly backfilled, or where settlement occurs, shall be reopened to the depth required for proper compaction, then refilled and compacted with the surface restored to the required grade and compaction.

2. **Pipe Backfilling.** Initial backfill that is defined as backfilling to a point 12 inches above the top of the pipe shall be done by either method a., b., c., or d. below. Secondary backfill that is defined as backfilling from a point 12 inches above the top of the pipe to the top of the trench or proposed subgrade elevation shall be completed in accordance with 400.3.E.2.e. "Secondary Backfill."

- a. **Suitable Excavated Material.** Fine compactable soil material may be used as the initial backfill; examples would include loam, sandy clay, sand and gravel, or soft shale, all of which shall be free from large clods of earth or stones. It shall be placed in uniform layers not more than 6 inches in depth (loose measurement) and shall be compacted to the density specified herein. Each layer of backfill material, if dry, shall be wetted uniformly to the moisture content required to obtain the specified density and shall be compacted to the required density, by means of a hand or mechanical tamper.

The maximum dry density and optimum moisture content shall be determined in accordance with TxDOT Test Method Tex-114-E. Tests for in place density shall be made in accordance with TxDOT Test Method Tex-115-E and within 24 hours after compacting operations are completed. If the material fails to meet the density specified, it shall be re-worked as necessary to obtain the density required.

Care shall be exercised to thoroughly compact the backfill under the haunches of the pipe and to insure that the backfill soil is in intimate contact with the sides of the pipe. Backfill material shall be kept at the same elevation on both sides of pipe.

Each lift of fill shall be compacted to the required density and moisture content as shown below, unless otherwise shown on the plans:

<b>Subgrade Material</b>	<b>Density</b>	<b>Moisture Content</b>
PI ≤ 20	≥ 95% of Max Dry Density	- 2% of Opt. or greater
PI > 20	≥ 95% of Max Dry Density	≥ Opt. Moisture

- b. **Cement Stabilized Sand.** When shown on the plans, backfill the excavation with cement stabilized sand backfill that conforms to Item 412, "Cement Stabilized Sand" to the elevations shown on the plans. Prevent the structure from being displaced during the placement of the cement stabilized sand and prevent the backfill from entering pipes. There is no separate pay item for Cement Stabilized Sand material, unless shown on the plans as a separate pay item for pipe backfill.

Before placing cement stabilized sand, the trench shall be cleaned of any extraneous material and thoroughly wet. All surplus dirt excavated from the trench shall be removed from the site.

- c. **Flowable Backfill.** When shown on the plans, backfill the excavation with flowable backfill that conforms to Item 413, "Flowable Backfill" to the elevations shown on the plans. Prevent the structure from being displaced during the placement of the flowable backfill and prevent flowable backfill from entering pipes. There is no separate pay item for Flowable Backfill material, unless shown on the plans as a separate pay item for pipe backfill.

Before placing flowable backfill, the trench shall be cleaned of any extraneous material and thoroughly wet. All surplus dirt excavated from the trench shall be removed from the site.

- d. **Select Fill or Flexible Base.** A clean gravel, or gravel approved by the Engineer, conforming to the requirements of article 410.3.B. "Gravel" of Item No.410, "Subgrade Filler" may be used for backfill material from the bottom of the trench to the top of the pipe. The gravel shall be placed in the trench in loose lifts not to exceed 10 inches in depth and lightly tamped to consolidate and seat the mass against conduit and earthen surfaces. Backfill material shall be kept at the same elevation on both sides of pipe.

A filter fabric shall be placed between the gravel backfill (initial backfill) and secondary backfill completely covering the top and sides of the gravel backfill. The filter material shall have an apparent opening size of U.S. Sieve No. 40. The filter fabric shall conform to the requirements of TxDOT DMS 6200, "Filter Fabric," Type1.

Where conditions permit and with approval of the Engineer, a gravel material conforming to Item 200 "Flexible Base" may be used from the top of the gravel filter bed to the top of the pipe. This backfill material shall be placed in uniform layers not more than 10 inches in depth (loose measurement) and shall be compacted to the required density. Each layer of material, if dry, shall be wetted uniformly to the moisture content required to obtain the specified density and shall be compacted to the required density by means of a mechanical tamper.

Compaction of the Flexible Base shall be such that the density of each layer shall be not less than 95% of the maximum dry density as determined by TxDOT Test Method TEX-114-E, unless otherwise shown on the plans.

- e. **Glass Cullet.** Glass cullet approved by the engineer, conforming to the requirements Item 411, "Glass Cullet use for Utility Bedding and Backfill," may be used for initial backfill. The glass cullet shall be placed in the trench and lightly tamped to consolidate and seat the mass against the conduit and earthen surfaces. Backfill material shall be kept at the same elevation on both sides of pipe.

A filter fabric shall be placed at the bottom of the trench directly on top of the exposed soil when bedding material is not used as well as between the top of the glass cullet (initial backfill) and the secondary backfill for the entire length and width of the trench. The filter fabric shall conform to the requirements of TxDOT DMS 6200, "Filter Fabric," Type1.

- f. **Secondary Backfill.** After the initial backfill has been completed to a point 12 inches above the top of the pipe by one of the methods outlined above, suitable rolling equipment may be used on these portions which are accessible to such equipment to obtain the compaction effect. Material for backfill shall be placed in uniform layers no more than 10 inches in depth (loose measurement) and shall be compacted to the density specified herein. Each layer of backfill material, if dry, shall be wetted uniformly prior to placement in the trench to the moisture content required to obtain the specified density, and shall be compacted to the required density by means of rolling equipment or other suitable mechanical method. No rolling equipment shall be used which may damage the pipe.

Each lift of fill shall be compacted to the required density and moisture content as shown below, unless otherwise shown on the plans:

<b>Subgrade Material</b>	<b>Density</b>	<b>Moisture Content</b>
PI ≤ 20	≥ 95% of Max Dry Density	- 2% of Opt. or greater
PI > 20	≥ 95% of Max Dry Density	≥ Opt. Moisture

- 3. **Quality Control.** In-place density tests shall be conducted by Engineer. The frequency and location of testing shall be in accordance with the following table:

<b>Secondary Backfill Depth (Ft)</b>	<b>Number of Tests per 400 Linear Feet</b>
0 – 6	3
6 – 12	5
> 12	7 or as directed by the Engineer

The number of tests shown above is a minimum. The Engineer may require more tests if there is a need.

Any failed test shall require the Contractor to remove and replace or rework as required the layer of backfill to points halfway to the next test location at no additional cost. Retests of these areas shall be at the Contractor’s expense

The Contractor shall provide access to the test area, associated trench excavation safety protection, and backfilling of the test areas at the Contractor’s expense.

**400.4. MEASUREMENT:** Excavation, Trenching and Backfill will not be measured for payment.

**400.5. PAYMENT:** No direct payment shall be made for excavation, trenching and backfilling for pipe culverts, pipe storm sewers, and all costs in connection therewith shall be included in the applicable contract price for the item to which the work pertains. No direct payment shall be made for placement of filter fabric and all costs in connection therewith shall be included in the applicable contract price for the item to which the work pertains.

**400.6. BID ITEM:**

Item 400.1 - Trench Excavation - per cubic yard

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**ITEM****407 CONCRETE ENCASUREMENT, CRADLES, SADDLES, AND COLLARS**

**407.1. DESCRIPTION:** *Place concrete encasements, cradles, saddles and collars, when called for by the plans or as directed by the Engineer.*

**407.2. MATERIALS:** All concrete shall conform to the provisions as shown below or as directed by the Engineer

**A. Concrete.** Item No. 300, "Concrete (Class B)" or shall be of the class as noted on the plans.

**407.3. EQUIPMENT:** Provide equipment as required to complete the work specified herein or as directed by the Engineer.

**407.4. CONSTRUCTION:**

**A. Concrete Encasement.** When concrete encasement is shown on the plans or when directed by the Engineer, the trench shall be excavated and fine graded to a depth conforming to the details and sections shown on the plans. The pipe shall be supported by precast concrete blocks of the same strength as the concrete for encasement and securely tied down to prevent floatation. Encasement shall then be placed to a depth and width conforming to the details and sections shown on the plans.

**B. Concrete Cradles.** When concrete cradles are shown on the plans or when called for by the Engineer the trench shall be prepared and the pipe supported in the same manner as described in concrete encasement of this specification and shall be constructed in accordance with details and sections shown on the plans.

**C. Concrete Saddles.** When shown on the plans or when directed by the Engineer, pipe to receive concrete saddles shall be backfilled in accordance with Item No. 400, "Excavation, Trenching, and Backfill" to the spring line and concrete placed for a depth and width conforming to the details and sections shown on the plans.

**D. Concrete Collars.** When shown on the plans or when directed by the Engineer concrete collars shall be constructed in accordance with details and sections shown on the plans.

**407.5. MEASUREMENT:** "Concrete Encasement, Cradles, Saddles, and Collars," will be measured by the cubic yard of accepted work, complete in place.

Reinforcing, if required, shall not be measured for payment.

**407.6. PAYMENT:** "Concrete Encasement, Cradles, Saddles and Collars" will be paid for at the unit price bid per cubic yard, which price shall be full compensation for furnishing and placing all materials, manipulation, labor, tools, equipment and incidentals necessary to complete the work.

**407.7. BID ITEM:**

Item 407.1 - Concrete Encasement - per cubic yard

N/A

## ITEM

### 413 FLOWABLE FILL

**413.1. DESCRIPTION:** *Furnish, mix, test and install flowable fill. Flowable fill is a concrete material suitable as a backfill for utility trenches, abandoned pipes, manholes and valves. It is a heavy material and will exert a high fluid pressure against any forms, embankment, or wall used to contain the backfill.*

**413.2. MATERIALS:**

- A. Cement.** Furnish hydraulic cement that meets the requirements of TxDOT's DMS-4600, "Hydraulic Cement," TxDOT's Hydraulic Cement Quality Monitoring Program (HCQMP), and ASTM C-150 Type I Portland Cement. Sources not on the HCQMP or other sources to be used in combination with an approved source will require approval before use.
- B. Fly Ash.** Furnish fly ash conforming to TxDOT DMS-4610, "Fly Ash."
- C. Chemical Admixtures.** Furnish chemical admixtures conforming to TxDOT DMS-4640, "Chemical Admixtures for Concrete."
- D. Fine Aggregate.** Provide fine aggregate that will stay in suspension in the mortar to the extent required for proper flow and that meets the gradation requirements of Table 1. Test fine aggregate gradation in accordance with TxDOT standard laboratory test procedure Tex-401-A. Plasticity Index (PI) must not exceed 6 when tested in accordance with TxDOT standard laboratory test procedure Tex-106-A.

**Table 1**  
**Aggregate Gradation Chart**

Sieve Size	Percent Passing
¾ in.	100
No. 200	0–30

- E. Mixing Water.** Use mixing water conforming to the requirements of Item 300, "Concrete."

**413.3. CONSTRUCTION:** Submit a construction method and plan, including mix design and shrinkage characteristics of the mix, for approval. Provide a means of filling the entire void area, and be able to demonstrate that this has been accomplished. Prevent the movement of any inserted structure from its designated location. If voids are found in the fill or if any of the requirements are not met as shown on the plans, remove and replace or correct the problem without additional cost to the City.

Unless otherwise shown on the plans, furnish a mix meeting the requirements of Sections 413.3.A, "Strength," and 413.3.B, "Consistency."

- A. Strength.** The compressive strength range, when tested in accordance with TxDOT standard laboratory test procedure Tex-418-A, must be between the following strength values unless otherwise directed by the Engineer or shown on the plans:

- 1. **Low Strength.** Between 80 psi and 150 psi at 28 days,

- 2. High Strength.** Greater than 500 psi at 28 days. For emergency repairs, strength shall be greater than 50 psi at 2 hours.

Two specimens are required for a strength test, and the compressive strength is defined as the average of the breaking strength of the 2 cylinders.

- B. Consistency.** Design the mix to be placed without consolidation and to fill all intended voids. Fill an open-ended, 3 inch diameter by 6 inch high cylinder to the top to test the consistency. Immediately pull the cylinder straight up. The correct consistency of the mix must produce a minimum 8 inch diameter circular spread with no segregation.

When necessary, use specialty type admixtures to enhance the flowability, reduce shrinkage, and reduce segregation by maintaining solids in suspension. All admixtures must be used and proportioned in accordance with the manufacturer's recommendations.

Mix the flowable fill using a central-mixed concrete plant, ready-mix concrete truck, pug mill, or other approved method.

Furnish all labor, equipment, tools, containers, and molds required for sampling, making, transporting, curing, removal, and disposal of test specimens. Furnish test molds meeting the requirements of TxDOT standard laboratory test procedure Tex-447-A. Transport, strip, and cure the test specimens as scheduled at the designated location. Cure test specimens in accordance with TxDOT standard laboratory test procedure Tex-447-A. The Engineer will sample, make, and test all specimens. Dispose of used, broken specimens in an approved location and manner. The frequency of job control testing will be at the direction of the Engineer.

- C. Shrinkage and Bleeding.** Limit shrinkage to 0.5% or less based upon the results from ASTM C 827, "Change in Height at Early Ages of Cylindrical Specimens from Cementitious Mixtures."

**413.4. MEASUREMENT:** This Item will be measured by the cubic yard of material placed. Measurement will not include additional volume caused by slips, slides, or cave-ins resulting from the Contractor's operations.

**413.5. PAYMENT:** The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Flowable Fill (Low Strength)," "Flowable Fill (High Strength)," or "Flowable Fill (High Strength emergency Repair)." This price is full compensation for furnishing, hauling, and placing materials and for equipment, tools, labor, and incidentals.

When shown on the plans or when other specifications indicate the use of flowable fill is incidental to another pay item, no direct payment for the material will be made.

**413.6. BID ITEMS:**

N/A

**DIVISION V - INCIDENTAL CONSTRUCTION****ITEM****500 CONCRETE CURB, GUTTER, AND CONCRETE CURB AND GUTTER**

**500.1. DESCRIPTION:** *Construct hydraulic cement concrete curb, gutter, and combined curb and gutter.*

**500.2. MATERIALS:** Furnish materials conforming to:

- A. Concrete.** Item 300, "Concrete." Use Class A concrete or material specified in the plans. Use Grade 8 coarse aggregate for extruded Class A concrete. Use other grades if approved by the Engineer.
- B. Reinforcing Steel.** Item 301, "Reinforcing Steel."
- C. Expansion Joint Materials.** Item 304, "Expansion Joint Materials."
- D. Membrane Curing Compound.** Item 305, "Membrane Curing."

**500.3. EQUIPMENT:**

- A. General.** Provide machinery, tools, and equipment necessary for proper execution of the work.
- B. Concrete Forms.** Forms shall be of metal and shall extend for the full depth of the concrete. Wooden forms may be used, when authorized by the Engineer, on short radius curves such as at street intersections and at such other locations for which curved metal forms may not be available. Wooden forms may be used in other situations when authorized by the Engineer.

All forms shall be free from warp and of sufficient strength to resist the pressure of the concrete without displacement. Bracing and staking of forms shall be such that the forms remain in both horizontal and vertical alignment until their removal. All forms shall be cleaned and coated with an approved form release agent or form oil before concrete is placed. Divider plates shall be of metal. Forms shall conform to the specified radius when placed on curves.

- C. Concrete Curbing Machine.** The curb, gutter, or curb and gutter may be constructed by the use of an automatic curb forming machine meeting the following requirements:
  - 1. The weight of the machine shall be such that required compaction is obtained without the machine riding above the bed on which curbing is constructed.
  - 2. The machine shall form curbing that is uniform in texture, shape and density.
  - 3. The forming tube of the extrusion machine or the form of the slipform machine must be easily adjustable vertically during the forward motion of the machine to provide variable heights necessary to conform to the established gradeline.

4. A pointer or gauge shall be attached to the machine so that a continual comparison can be made between the extruded or slipform work and the grade guideline. Other methods may be used when approved by the Engineer.

**500.4. CONSTRUCTION:** Curbs, gutters, or curb and gutter combinations may be placed using conventionally formed concrete placement or using a City approved self-propelled concrete curbing machine.

Provide finished work with a well-compacted mass and a surface free from voids and honeycomb, in the required shape, line, and grade. Round exposed edges with an edging tool of the radius shown on the plans. Mix, place, and cure concrete in accordance with Item 307, "Concrete Structures." Construct joints at locations shown on the plans. Cure for at least 72 hours unless approved by the Engineer.

Furnish and place reinforcing steel in accordance with Item 301, "Reinforcing Steel."

Set and maintain a guideline that conforms to alignment data shown on the plans, with an outline that conforms to the details shown on the plans.

#### **A. Formed Concrete.**

1. **Excavation and Foundation.** Excavate, shape and compact subgrade, foundation, or pavement surface to the line, grade, and cross section shown on the plans. Lightly sprinkle subgrade or foundation material immediately before concrete placement.

If the subgrade is undercut, or the natural ground is below "top of subgrade," the necessary backfill shall be made with an approved material and compacted with a mechanical tamper. Hand tamping will not be permitted.

2. **Placement.** Place concrete into forms, and strike off with a template  $\frac{1}{4}$  to  $\frac{3}{8}$  inch less than the dimensions of the finished curb unless otherwise approved. After initial set, plaster surface with mortar consisting of 1 part hydraulic cement and 2 parts fine aggregate. Brush exposed surfaces to a uniform texture.

Place curbs, gutters, and combined curb and gutters in 50 foot maximum sections unless otherwise approved.

The reinforcing steel, if required, shall be placed in position as shown on the typical section. Care shall be exercised to keep all steel in its proper location.

Expansion joint material shall be provided at intervals not to exceed 50 feet, and shall extend the full width and depth of the concrete. Templates for joints shall be of steel, not less than  $\frac{3}{16}$  of an inch in thickness and patterned to the shape of the curb. Templates shall be cleaned and oiled and spaced to cut the curb in sections 10 feet in length. The templates shall extend a distance of 8 inches into the curb from the top down.

Two round smooth dowel bars  $\frac{3}{8}$  of an inch in diameter and 18 inches in length shall be installed at each expansion joint. One 9 inch end of each dowel shall be thoroughly coated with hot oil asphalt so that it will not bond to the concrete; approved types of slip joints may be used in lieu of coating ends of dowels. The dowels shall be placed on the vertical centerline 3 inches from the top and bottom.

Immediately after finishing the curb, it shall be protected by a membrane-compound curing agent.

The curb shall be backfilled to the full height of the concrete, tamped and sloped as directed by the Inspector. The top 4 inches of fill shall be of clean top soil, free of stones and debris.

## **B. Machine Laid Concrete.**

- 1. Foundation.** Hand-tamp and sprinkle subgrade or foundation material before concrete placement. Provide clean surfaces for concrete placement. If required, coat cleaned surfaces with approved adhesive or coating at the rate of application shown on the plans or as directed.
- 2. Placement.** The concrete shall be fed into the machine in such a manner and at such consistency that the finished curb will present a well compacted mass with a surface free from voids and honeycomb and true to established shape, line and grade.

Immediately following extrusion any voids between the trench walls and curb shall be filled with well compacted concrete and finished off flush with the surface of the base. Any additional surface finishing specified and/or required shall be performed immediately after the above void-filling operation. Joints shall be cut to a depth of  $\frac{1}{2}$  inch at 10 foot intervals or as directed by the Inspector.

Whenever the curb end abuts a concrete structure a  $\frac{1}{2}$  inch, pre-molded, expansion joint, conforming to the curb section, shall be placed between the two concrete surfaces.

Whenever extrusion is suspended long enough to produce a cold joint,  $\frac{3}{8}$  inch smooth dowel bars, 18 inches long, shall be embedded 9 inches into the completed curb, one-quarter ( $\frac{1}{4}$ ) curb height from top and bottom. The end of the curb at the point of suspension of extrusion shall be cut back until all remaining concrete is of a dense well compacted nature.

Any addition of concrete to the extruded curb is to be applied and finished before the extruded curb has achieved its initial set.

When finishing operations are completed the curb is to be coated with membrane curing compound.

When the curb has cured, it shall be backfilled to the full height of the concrete, tamped and sloped as directed by the Inspector. The top 4-inches of fill shall be clean top soil, free of stones and debris.

**500.5. MEASUREMENT:** Accepted work as prescribed by this item will be measured by the linear foot of concrete curb, complete in place.

**500.6. PAYMENT:** The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Concrete Curb," "Concrete Curb (Mono)," "Concrete Gutter," or "Concrete Curb and Gutter" of the type specified. This price is full compensation for surface preparation of base, equipment, labor, materials, tools, and incidentals. Topsoil to be paid under Item 515, "Topsoil."

**500.7. BID ITEM:**

N/A

**ITEM****504 CONCRETE MEDIANS AND ISLANDS**

**504.1. DESCRIPTION:** *Construct cast-in-place concrete medians and directional islands.*

**504.2. MATERIALS:** Furnish materials in accordance with the following:

**A. Hydraulic Cement Concrete.** Item 300, "Concrete." Use Class A concrete or other concrete as specified. Use other grades if approved by the Engineer.

**B. Reinforcing Steel.** Item 301, "Reinforcing Steel."

**C. Wire Mesh.** Item 303, "Welded Wire Flat Sheets."

**D. Concrete Structures.** Item 307, "Concrete Structures."

**504.3. EQUIPMENT:** Furnish equipment as required and/or in accordance with the pertinent Items.

**504.4. CONSTRUCTION:** When shown on the plans, install root barriers behind the curbs of the median or island to reduce potential future damage to the adjoining pavement in accordance with the locations and depths shown on the plans. Unless otherwise shown on the plans, the root barrier shall be thermoplastic panels or sheets.

Provide wood or metal forms securely held in place. Properly position and secure reinforcing steel and dowels. Place concrete for each section on the prepared foundation to line, grade, and cross-section, in accordance with Item 307, "Concrete Structures." Separate sections from adjacent curbs or adjoining sections using expansion or contraction joints of the type and size specified on the plans. A curb section may be used for the perimeter of the median or island when shown. Construct curbs in conformance with Item 500, "Concrete Curb, Gutter, and Combined Curb and Gutter."

Finish exposed surfaces with a wood float after sufficient concrete set. Round exposed edges as shown on the plans.

Remove forms after concrete has set. Point up exposed surfaces. Provide an ordinary surface finish in accordance with Item 307, "Concrete Structures." Use mortar consisting of 1 part hydraulic cement and 2 parts fine aggregate to plaster exposed formed surfaces when required. Apply the mortar with a template made to conform to the cross-section shown on the plans.

Cure at least 72-hours using a method specified in Item 307, "Concrete Structures."

**504.5. MEASUREMENT:** This Item will be measured by the square yard to the face of the curb.

**504.6. PAYMENT:** The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Concrete Median" or "Concrete Directional Island." This price is full compensation for preparing foundation surfaces; furnishing and operating equipment; curbs and gutters used as part of the concrete median or directional island; and labor, materials, tools, and incidentals.

**504.7. BID ITEM:**

Item 504.1 - Concrete Median - per square yard

Item 504.2 - 3' x 4' Concrete Pedestal - each

Item 504.3 - 4' x 10' Concrete Pedestal - each

**ITEM****507 CHAIN LINK WIRE FENCE**

**507.1. DESCRIPTION:** *This item shall govern for chain link fabric supported on posts and with bracing and accessories as shown in the plans or as specified herein, erected complete in place as shown in the plans or as directed by the inspector.*

**507.2. MATERIALS:** Before installation of the chain link fence, furnish certification from the fence materials manufacturer stating that all fencing materials comply with the requirements of this Item. Use only new materials.

**A. General.** Furnish materials in accordance with the following:

1. **Concrete.** Item 300, "Concrete," Class "B."
2. **Galvanizing.** Texas Department of Transportation Item 445, "Galvanizing."

**B. Fabric.** Provide wire fabric with:

1. Nine (9) gauge (0.148 in. diameter) steel wire with a minimum breaking strength of 1,290 lb. meeting ASTM A 392 Class I or ASTM A 491;
2. mesh size of 2 in.  $\pm$  1/8 in. between parallel wires with at least 7 meshes in a vertical dimension of 23 in. along the diagonals of the openings; and
3. knuckled selvages at the top and bottom edge of the fabric, unless otherwise shown on the plans.

**C. Posts.** Provide posts of the size and weight shown on the plans. Do not provide rerolled or open-seam posts. Use material meeting ASTM F 1083 for all posts. When specified, furnish thin-wall, high-strength pipe posts manufactured by cold rolling using steel strip conforming to ASTM A 1011, CS (Commercial Steel).

**D. Post Caps.** Provide malleable iron post caps designed to exclude all moisture. If barbed wire is shown on the plans, furnish barbed wire support arms integral with the post caps. If top rail is shown on the plans, furnish post caps with an opening for the top rail. Post caps must have a 2-in. skirt.

**E. Gates.** Provide gates fabricated from round sections of pipe of the size and weight shown on the plans. Use material meeting ASTM F 1083 for all gate pipes. For each gate, include:

1. corner and tee fittings of malleable iron or pressed steel with means for attaching diagonal bracing members;
2. hinges of malleable iron allowing a full 180° swing, easily operated by one person;
3. ball-and-socket-type bottom hinges that do not twist or turn from the action of the gate and prevent the closed gate from being lifted off the hinges;
4. a positive stop that prevents any portion of the gate from swinging over an adjacent traffic lane;

5. malleable iron pulley systems for roll type gate (only when required);
  6. diagonal braces consisting of  $\frac{3}{8}$ -in.-diameter cable with turnbuckles, 2 to each gate frame, and, for vehicle gates, a vertical pipe brace of the size and weight shown on the plans at the center of each gate leaf;
  7. latches of malleable iron or steel for single gates with a single-fork latch and padlock eye that will keep the gate closed;
  8. two fork latches mounted on a center plunger rod with a padlock eye for double-leaf gates;
  9. holdbacks for each leaf of vehicular gates, with a semi-automatic holdback catch anchored at least 12 in. into a 12 in.-diameter by 24 in.-deep concrete footing; and
  10. a malleable iron center rest, designed to receive the plunger rod anchored as shown on the plans for all double-leaf gates.
- F. Top Rail.** When shown on the plans, provide top rail manufactured from 1.660 in. OD standard weight (Schedule 40) steel pipe weighing 2.27 lb. per foot or high-strength pipe weighing 1.82 lb. per foot. Use material meeting ASTM F 1083 for all top rail pipes. Provide pipe in sections at least 18 ft. long joined with outside steel sleeve couplings at least 6 in. long with a minimum wall thickness of 0.70 in. Use couplings designed to allow for expansion of the top rail.
- G. Tension Wire.** Unless shown on the plans, use 7 gauge (0.177-in.) carbon steel wire with a minimum breaking strength of 1,950 lb. for the bottom edge of all fence fabric, and for the top edge of fence fabric when a top rail is not specified.
- H. Truss Bracing.** Provide truss bracing as shown on the plans.
- I. Stretcher Bars.** Provide stretcher bars made of flat steel at least  $\frac{3}{16}$  in. by  $\frac{3}{4}$  in. and not more than 2 in. shorter than the fabric height. Provide 1 stretcher bar for each gate and end post and 2 stretcher bars for each corner and pull post.
- J. Grounds.** Provide copper-clad steel rods 8 ft. long with a minimum diameter of  $\frac{5}{8}$  in., or other UL-listed ground rods.
- K. Tie Wire.** Wire for attaching fabric to tension wire and to top rail shall be not less than No. 12 gauge galvanized wire, or fastenings in accordance with the manufacturer's standard design. Sufficient fastening material shall be furnished to provide for attaching the fabric to the tension wire and to the top rail and posts at the spacing shown on the plans.
- L. Braces and Cables.** Braces or cables shall be installed at all corner, tension, terminal and gate posts and shall be extended to adjacent line posts, in accordance with the plans. Braces and trussing material shall be high carbon steel of good commercial quality and shall meet the dimensions and other requirements on the plans. Brace rods shall be  $\frac{3}{8}$  inch diameter and be equipped with turnbuckles. Cables shall be  $\frac{3}{8}$  inch diameter and shall be composed of seven wires. Cables shall be installed as shown on the plans, and shall include the use of  $\frac{3}{8}$  inch drop-forged eye-and-eye, or eye-and-clevis turnbuckles.

- M. Steel Pipe.** All steel pipe, except for thin-wall, high strength pipe, used for top rails, line posts, corner, tension, terminal or gate posts, braces or gate frames shall conform to the requirements of ASTM A 120. Thin-wall, high strength pipe shall be manufactured by cold rolling using steel strip conforming to ASTM A 569.
- N. Galvanizing and Aluminum Coating.** Unless specified on the plans, hot-dip galvanize all materials. Fabric and tension wire may be aluminum coated or alloy-coated if approved. When shown on the plans, additionally coat all material except bolts, nuts, and washers with thermally fused polyvinyl chloride (PVC) in accordance with ASTM F 668, Class 2B, meeting the specified color.
- 1. Fabric.**
    - a. Galvanizing.** Hot-dip galvanize in accordance with ASTM A 392, Class I.
    - b. Aluminum Coating.** Aluminum-coat in accordance with ASTM A 491.
    - c. Alloy Coating.** Coat with zinc-5% aluminum-mischmetal alloy (Zn-5A1-MM) in accordance with ASTM F 1345, Class I.
  - 2. Posts.**
    - a. Inside and Outside Galvanizing.** Hot-dip galvanize inside and outside in conformance with ASTM F 1083.
    - b. Alloy Coating.** Coat inside and outside with Zn-5A1-MM in accordance with ASTM F 1043, Class C.
  - 3. Braces and Gates.**
    - a. Galvanizing.** Hot-dip galvanize braces and gates inside and out in conformance with ASTM F 1083.
    - b. Alloy Coating.** Coat inside and out with (Zn-5A1-MM) in accordance with ASTM F 1043, Class C.
  - 4. Fittings, Bolts, and Other Miscellaneous Hardware.** Galvanize all fittings, bolts and miscellaneous hardware in conformance with TxDOT Item 445, "Galvanizing."
  - 5. Tension Wire.** Zinc-coat tension wire with a minimum coating of 0.80 oz./sq. ft. or aluminum-coat with a minimum coating of 0.30 oz./sq. ft.
  - 6. Barbed Wire.** Zinc-coat barbed wire in accordance with ASTM A 121 (0.80 oz./sq. ft.) or aluminum-coat in accordance with ASTM A 585 (0.30 oz./sq. ft.).
  - 7. Pull Cable.** Zinc-coat pull cable with a minimum coating of 0.80 oz./sq. ft. of individual-wire surface when tested in conformance with ASTM A 116.
- O. Sampling.** If there is reason to confirm the Certification provided in 507.2, "Materials," the Contractor shall furnish, upon request of the Engineer, samples of each component part of the fence, including fittings. These samples shall be subjected to the galvanizing, weight and, where applicable, strength tests. A sample may be taken from each shipment and all samples shall be furnished to the City without cost. If a sample or specimen fails to meet the

- requirements of this specification, two additional samples or specimens shall be taken from the same shipment and tested, either samples or specimens so tested shall meet the requirements in every respect, or the lot represented by the samples may be rejected.
- 507.3. EQUIPMENT:** Provide the machinery, tools and equipment necessary for proper prosecution of the work. All machinery, tools and equipment used shall be maintained in a satisfactory and workmanlike manner.
- 507.4. CONSTRUCTION:** Erect the chain link fence to the lines and grades established on the plans. Overall height of the fence when erected is the height above the grade shown.
- A. Clearing and Grading.** Clear all brush, rocks, and debris necessary for the installation of this fencing. Unless otherwise shown on the plans, stake the locations for corner posts and terminal posts. Follow the finished ground elevations for fencing panels between corner and terminal posts. Level off minor irregularities in the path of the fencing.
- B. Erection of Posts.** Install posts as shown on the plans. Plumb and permanently position posts with anchorages firmly set before fabric is placed. Brace corner and pull posts as shown on the plans.
- 1. Post Spacing.** Space posts as shown in Table 1.

**Table 1**  
**Post Spacing and Placement**

<b>Post Type</b>	<b>Required Spacing of Placement</b>
Line Posts	at most 10 ft. apart
Tension Posts	at most 330 ft. apart and at each change in direction exceeding 20° vertically
Corner Posts	at each horizontal angle point

Install cables on all terminal posts and extend to adjacent posts. Install cables on each side of corner and pull posts with a 3/8-in. drop-forged eye-and-eye or eye-and-clevis turnbuckle, unless otherwise shown on the plans.

- 2. Postholes.** Drill holes for concrete footings for all posts to provide footings of the dimensions shown on the plans.

Where solid rock is encountered before reaching plan depth, penetrate the solid rock by at least 12 in. (18 in. for end, corner, gate, and pull posts) or to plan depth. Drill holes in the solid rock with a diameter at least 1 in. greater than the outside diameter of the post.

After the posts are set and plumbed, fill the hole in the solid rock with grout consisting of 1 part hydraulic cement and 3 parts clean, well-graded sand. Other grouting materials may be used if approved. Thoroughly work the grout into the hole, leaving no voids. Construct concrete footings from the solid rock to the top of the ground.

- 3. Gate Posts.** Align the tops of all gate frames with the fencing top tension wire or top rail. If curbs are shown on the plans, provide vehicular gates that are greater in overall height than the adjacent fencing by the height necessary to extend to within 2 in. of the pavement between the curbs.

- 4. Concrete Footings.** Center posts in their footings. Place concrete and compact by tamping or other approved methods. Machine mix all batches of concrete over  $\frac{1}{2}$  cu. yd. Hand mixing concrete is allowed on batches under  $\frac{1}{2}$  cu. yd.

Use forms for footings where the ground cannot be satisfactorily excavated to neat lines. Crown the concrete or grout (for solid rock) to carry water from the post. Keep the forms in place for at least 24 hr. Backfill the footing with moistened material as soon as each form is removed, and thoroughly tamp. Cover concrete with at least 4 in. of loose moist material, free of clods and gravel, immediately after placing concrete. No other curing is required.

Spread all excess excavated and loose material used for curing neatly and uniformly. Remove excess concrete and other construction debris from the site.

- C. Erection of Fabric.** After all posts have been permanently positioned and anchorages firmly set, place the fabric with the cables drawn taut with the turnbuckles. Secure one end and apply enough tension to the other end to remove all slack before making attachments. Unless otherwise shown on the plans, cut the fabric and independently attach each span at all corner posts and pull posts.

Follow the finished contour of the site with the bottom edge of fabric located approximately 2 in. above the grade. Grade uneven areas so the maximum distance between the bottom of fabric and ground is 6 in. or less. Fasten fabric at 12 in. intervals to the top and bottom tension wires between posts. When top rail is shown on the plans, fasten the fabric in the same manner. On gate frames, fasten the fabric to the top and bottom of the gate frame at 12 in. intervals. Use steel wire fabric ties of 9 gauge steel or larger.

Fasten fabric to terminal posts by steel stretcher bars and stretcher bar bands fitted with carriage bolts and nuts of the size and spacing shown on the plans. Use stretcher bars to fasten endposts, pull posts, corner posts, and gateposts with stretcher bar bands at intervals of at most 15 in. Attach stretcher bars to terminal posts with 1 in.  $\times$   $\frac{1}{8}$  in. flat steel bands with  $\frac{3}{8}$ -in. carriage bolts at intervals up to 15 in.

- D. Electrical Grounds.** Provide at least 1 electrical ground for each 1,000 ft. of fence, located near the center of the run. Provide additional grounds directly under the point where power lines pass over the fence. Vertically drive or drill in the grounding rod until the top of the rod is approximately 6 in. below the top of the ground. Connect a No. 6 solid copper conductor to the rod and to the fence by a UL-listed method so that each element of the fence is grounded.

- E. Repair of Coatings.** Repair damaged zinc coating in accordance with TxDOT Item 445, Section 445.3.D, "Repairs."

- 507.5. MEASUREMENT:** "Chain Link Wire Fence," of the height specified, will be measured by the linear foot of fence at the bottom of the fabric along the center line of the fence from center to center of end posts, exclusive of gates. "Chain Link Wire Fence" shall include all end posts, angle and corner posts, and tension posts, complete in place with all bracing and accessories.

Gates will be measured per each gate of each type, complete in place with gate posts, all bracing and all accessories.

- 507.6. PAYMENT:** "Chain Link Wire Fence" measured as prescribed above, will be paid for at the contract unit price bid per linear foot for "Chain Link Wire Fence" of the height specified, which

price shall be full compensation for furnishing and installing all fencing materials, end posts, angle and corner posts, tension posts, line posts, caps, tension wires, top rail, and connection fittings; digging post holes or setting into retaining wall and structures; furnishing and placing concrete for setting posts; all hauling and hauling charges; and for all manipulation, labor, tools, equipment, and incidentals necessary to complete the work.

Gates measured as prescribed above will be paid for at the contract unit price bid for each "Gate, Pedestrian" or "Gate, Vehicular" of each size called for, which price shall be full compensation for furnishing all materials; fabrication, preparation, hauling, handling charges, and erecting; including gate and gate posts, posts caps, braces, miscellaneous fitting and fastenings, latches, hinges, stops and holding devices; and for all manipulation, labor, tools, concrete for setting posts, equipment and incidentals necessary complete installation.

**507.7. BID ITEM:**

Item 507.1 - Chain Link Wire Fence - (4 ft. high) - per linear foot

Item 507.2 - Chain Link Wire Fence - (6 ft. high) - per linear foot

Item 507.3 - N/A

Item 507.4 - N/A

Item 507.5 - Gates - Vehicular - per opening

## ITEM

### 511 CUTTING AND REPLACING PAVEMENTS (TRENCH REPAIR)

- 511.1. DESCRIPTION:** *Cut pavements, remove base, and replace base material and pavements on cuts up to six (6) feet in width.*
- 511.2. MATERIALS:** Furnish materials conforming to the following:
- A. Tack Coat.** Item 203, “Tack Coat.”
  - B. Surface Treatments.** Item 204, “Surface Treatments.”
  - C. Hot Mixed Asphaltic Concrete Pavement.** Item 205, “Hot Mixed Asphaltic Concrete Pavement.”
  - D. Asphalt Treated Base.** Item 206, “Asphalt Treated Base.”
  - E. Hydraulic Cement Concrete.** Item 300, “Concrete.”
  - F. Reinforcing Steel.** Item 301, “Reinforcing Steel.”
  - G. Membrane Curing Compound:** Item 305, “Membrane Curing.”
- 511.3. EQUIPMENT:** Furnish equipment in accordance with the pertinent Items. Use of a motor grader will be permitted for placement of asphalt concrete pavement unless otherwise shown on the plans.
- 511.4. CONSTRUCTION:** Repair using one or more of the following operations as shown on the plans. Cut neat vertical faces around the perimeter of the work area when removing pavement structure layers. Removed materials are the property of the Contractor unless otherwise shown on the plans. Dispose of removed material in accordance with federal, state, and local regulations. Provide a smooth line and grade conforming to the adjacent pavement.
- A. Removing Upper Pavement Layers.** All concrete and asphaltic concrete pavements shall be cut with a concrete saw or other approved equally capable equipment. If necessary, remove adjacent soil and vegetation to prevent contamination of the repair area, and place it in a windrow. Do not damage adjacent pavement structure during repair operations.
    - 1. Cutting Existing Asphaltic Concrete Layers.** The depth of the cut shall be such that upon removal of asphaltic concrete, the sides of the cut will be straight and square. Where existing base materials are to remain, pavements shall be removed to their full depth up to the top of the base material. Care shall be taken not to damage the existing base. If subgrade work is required, remove flexible pavement structure layers from work area.
    - 2. Cutting Existing Portland Cement Concrete Layers.** Remove areas identified by the Engineer. Saw-cut and remove existing asphalt concrete overlay over the repair area and at least 6 inches outside each end of the repair area. Saw-cut full depth through the concrete around the perimeter of the repair area before removal. Do not spall or fracture concrete adjacent to the repair area. Care shall be taken, when cutting concrete pavement, not to cut transverse reinforcing steel.

3. **Cutting Surface Treatments.** Asphalt surface treatments shall be cut by means of sharp axes or hand held pneumatic tools with wedge bits, or other approved equipment.

**B. Removal of Underlying Layers (Bases).**

1. **Concrete and Cement Stabilized Bases:** Remove by means of hand held pneumatic pavement breakers with approved cutting bits. It is the intent of this specification that the base shall be removed in a manner that will leave the sides of the cut straight and square.

Where reinforcement is encountered in concrete bases, a minimum of 1 foot shall be cleaned of all old concrete and left in place to tie to new reinforcement in the new concrete base.

2. **Flexible Bases.** Remove by normal trenching operations.

**C. Replacement of Underlying Layers (Bases).**

1. **Concrete Base.** Replace concrete bases with Class "A" concrete conforming to the provisions of Item 300, "Concrete." If existing concrete is steel reinforced, the reinforcing steel shall be replaced in accordance with Item No. 301, "Reinforcing Steel." The concrete shall have a slump of not more than 3 inches and shall be spaded, tamped and finished to the satisfaction of the Engineer. Immediately following finishing operations, the surface shall be cured in accordance with the provisions of Item 305, "Membrane Curing." The concrete shall be protected from traffic for seventy-two (72) hours.
2. **Stabilized or Flexible Base.** Unless otherwise shown on the plans, replace cement stabilized, asphalt treated, asphaltic concrete, or flexible bases with Type B asphaltic concrete base in accordance with Item 205, "Hot Mix Asphaltic Concrete Pavement" or other materials approved by the Engineer.

**D. Replacement of Upper Pavement Layers.** Pavement layers shall be replaced under this item in the thickness and type shown on the plans or as directed by the Engineer.

1. **Asphaltic Concrete.** Hot mix asphaltic concrete shall be furnished and placed in accordance with Item 205, "Hot Mix Asphaltic Concrete Pavement." All concrete bases shall receive a tack coat of asphalt or emulsion in accordance with the provisions of Item 203, "Tack Coat" prior to placement of hot mix asphaltic concrete.
2. **Portland Cement Concrete.** When Portland cement concrete pavement is indicated on the plans as the replacement pavement, "Class A" concrete in accordance with Item 300, "Concrete," shall be placed conforming to the methods described in 511.4.C.1. "Concrete Bases." The concrete shall be placed, spaded, tamped and finished to the line, grade and texture of the surrounding concrete pavement.
3. **Surface Treatments.** Where the existing pavement is shown to be a single or double surface treatment on the plans, the replacement surface pavement will not be constructed under this item. Such surface treatments will be constructed to the widths and details shown on the plans and measured and paid under Item 204, "Surface Treatments" or other items as directed by the Engineer.

**511.5. MEASUREMENT:** Cutting and replacing pavements will be measured by the square yard of pavement so cut and replaced, of the type and depth indicated in the plans and bid proposal and of the limits shown in the plans. Materials used in replacing bases and pavements such as flexible base, cement stabilized base, concrete, reinforcing steel, prime coat, tack coat and asphaltic concrete pavement will not be measured directly for payment. Depth will be measured from the top of pavement to the bottom of new base material.

**511.6. PAYMENT:** Payment for cutting and replacing pavements will be made at the contract unit price bid per square yard for “Cutting and Replacing Pavements” of the type and depth classification shown on the plans. Where the depth of replaced base and pavement differs from that shown on the plans and bid proposal, the contract unit price bid per square yard shall be adjusted by the ratio of the actual depth of pavement and base replaced to the depth shown on the plans and in the bid proposal. Such variations in depth shall be subject to approval of the Engineer in writing.

The contract unit price bid for “Cutting and Replacing Pavements” shall be considered as full compensation for cutting pavements, removing bases, replacing bases and pavements, removing and disposing of all surplus materials, furnishing and placing all new materials, and for all manipulations, work, tools, equipment, labor and incidentals necessary to complete the work.

**511.7. BID ITEMS:**

N/A

## ITEM

### 514 PAINT AND PAINTING

**514.1. DESCRIPTION:** *This item shall govern for type, quality, and testing of paints, their source, and for the application of paint to structures and appurtenances. The painting of structures and appurtenances shall include, unless otherwise provided in these specifications, or the contract, the preparation of the surfaces, the application, protection and drying of the paint coatings, the protection of all traffic upon, underneath, or near the structure, the protection of all parts of the structure against disfigurement by any and all of the painting operations.*

**Notice of Intent.** The intent of this specification is to procure the specified paints in place on structures and/or railings, so that the durability and protective value of these paints will be realized in service. Accordingly, the best quality materials and workmanship are implied throughout.

Surface conditions and application requirements are specified with the intent to obtain full adhesion of paint to clean, dry, firm surfaces on the bare metal and between coats. This will require careful attention to preparation of surface, to prevention contamination and marring of coating during and after drying, and to uniform, skilled application.

Portions of structures entailing difficult application of the field coats after erection may be completely painted before assembling or erection at the discretion of the Engineer.

**514.2. MATERIALS:** Provide the paint system (surface preparation, primer, intermediate, and appearance coats as required) shown on the plans. Provide System II with #742 Gray Appearance Coat if no system is specified. Provide a concrete gray appearance coat (Federal Standard 595B color 35630) if appearance coat is required unless otherwise shown on the plans.

If faying surfaces will be painted, provide a prime coat that is documented to have the required slip and creep characteristics (as determined by "Testing Method to Determine the Slip Coefficient for Coatings Used in Bolted Joints" in the Research Council on Structural Connections' Specification for Structural Joints Using ASTM A 325 or A 490 Bolts) to meet the required mean slip coefficient shown on the plans. Perform all required testing at no expense to the City.

**A. Paint Systems.** Standard paint systems for painting new and existing steel include the following.

- 1. System I (Overcoating).** Provide paint in accordance with Texas Department of Transportation (TxDOT) Departmental Material Specification DMS-8101, "Structural Steel Paints-Performance." Provide a penetrating sealer, intermediate prime coat on bare steel areas, and an appearance coat in accordance with manufacturer's specifications. This system is used for repainting existing steel and used only when specified on the plans.
- 2. System II.** Provide #810 Prime Coat meeting TxDOT DMS-8100, "Structural Steel Paints-Formula." For appearance coat, provide either #742 Gray Appearance Coat meeting TxDOT DMS-8100 or acrylic latex meeting TxDOT DMS-8101, "Structural Steel Paints-Performance," as specified. This system is used for painting new steel and repainting existing steel.

3. **System III.** Provide paint in accordance with TxDOT DMS-8101, "Structural Steel Paints-Performance." Provide inorganic zinc (IOZ) prime coat, epoxy intermediate coat, and urethane appearance coat for all outer surfaces except those to be in contact with concrete. Provide epoxy zinc prime coat for areas to be in contact with concrete and for touchup of IOZ. This system is used for painting new steel.
  4. **System IV.** Provide paint in accordance with TxDOT DMS-8101, "Structural Steel Paints-Performance." Provide IOZ prime coat and acrylic latex appearance coat for all outer surfaces except those to be in contact with concrete. Provide epoxy zinc prime coat for areas to be in contact with concrete and for touchup of IOZ. This system is used for painting new steel.
- B. Paint Inside Tub Girders and Closed Boxes.** Provide a white polyamide cured epoxy.
- C. Paint over Galvanizing.** Provide epoxy intermediate coat and urethane appearance coat in accordance with TxDOT DMS-8101, "Structural Steel Paints-Performance." Provide intermediate coating recommended by the manufacturer for use on galvanized steel.
- D. Special Protection System.** Provide the type of paint shown on the plans.

**514.3. EQUIPMENT:** Ensure that spray equipment:

- has adequate capacity and sufficient gauges, filters, agitators, regulators, and moisture separators to ensure delivery of clean dry air at the proper pressure and volume;
- is adequate for the type of paint being used;
- has spray heads that provide a smooth, uniform coat of paint;
- can separate moisture from air stream in contact with the paint; and
- has no dried coatings, solvents, or other foreign matter on surfaces that paint is likely to contact.

Maintain all equipment and accessories in good working order.

During painting operations, keep paint pots no more than 20 ft. above or below the level of spray application of paint. Do not allow fluid hoses to sag more than 10 ft. below the level of the bottom of the paint pot or actual spraying operations, whichever is the lowest point. Keep hoses serviceable with no cracks or deterioration. Equip paint pots (or other containers from which the paint is dispensed) with agitators that operate whenever paint is in the pot.

- A. Airless Spray Equipment.** Use regulator and air or fluid pressure gauges. Use fluid hoses with at least ¼ in. I.D. and a maximum length of 75 ft.
- B. Conventional Spray Equipment.** Use independent fluid pressure and atomization pressure regulators and gauges. Use fluid and air hoses with at least ½ in. I.D. and a maximum length of 75 ft.

**514.4. CONSTRUCTION:**

- A. Qualification.** Certification of the cleaning and painting contractor, subcontractor, or fabricator is required as follows.
1. **Shop Cleaning and Painting.** Follow all applicable provisions for qualification specified in the AASHTO/NSBA Steel Bridge Collaboration S8.1.

**2. Field Cleaning and Painting.** Maintain SSPC-QP 1 (for paint application and removal of coatings not containing hazardous materials) and SSPC-QP 2 (for removal of coatings containing hazardous materials) certification for the duration of the project when the following conditions exist:

- total steel surface area to be cleaned and painted exceeds 15,000 sq. ft.,
- existing coating to be removed from steel contains hazardous materials as specified on the plans, or
- certification is required on the plans.

Submit proof of certification before beginning work.

**B. Responsibility for Hazards.** Some paints and cleaning products are harmful to health. Handle all paints and cleaning products in accordance with the information on the manufacturer's safety data sheet and in accordance with all applicable federal and state regulations. Comply with all worker and public safety protection measures including 29 CFR 1926.62 when cleaning requires removing paint containing lead or chromium. Monitor permissible exposure limits (PEL) in accordance with OSHA requirements.

**C. Access.** Provide safe access to all parts of the work for proper inspection. Do not place rigging, scaffolds, etc., in contact with previously painted surfaces until the previously applied coating has had at least 48 hours of curing time. Protect previously painted and cured surfaces with an approved padding to minimize damage when rigging, scaffolds, etc., will be placed on or hung from those surfaces. Repair all coating damaged as a result of rigging or scaffolding as directed.

Remove tree limbs, bushes, grass, and other items that will interfere with the cleaning and painting operations as directed. Remove vertical clearance signs, and erect and maintain temporary ground-mounted signs matching the content and letter size on the existing sign unless otherwise directed. Re-attach permanent clearance signs as directed.

**D. Steel to be Painted.** Clean and paint all structural steel except weathering steel that is to remain unpainted, unless otherwise shown on the plans. Structural steel includes all main members, bearing apparatus, diaphragms, and lateral bracing where applicable. Unless otherwise shown on the plans or exempted in this Item, paint the rolling faces of rockers and base plates, all surfaces of bearing plates, and all surfaces of iron or steel castings, whether or not the surfaces are milled. Unless otherwise provided in the Contract or approved in writing, perform the initial cleaning and application of required prime and intermediate coatings on new steel before shipment of the steel to the job site.

**E. Painting Galvanized Surfaces.** Do not water-quench or chromate-quench galvanized surfaces to be painted. Wash the surface to be painted with a biodegradable alkaline detergent to remove oil, grease, flux, white rust, dirt, and any other contaminants. Thoroughly rinse the surface with potable water to remove remaining detergent. Remove remaining oily contamination with a clean solvent. Properly label and store. Recycle or dispose of spent solvents.

Lightly abrasive-blast the surface to be painted, or use another approved method to show an etched pattern on the entire surface without removing any of the zinc. Apply primer within 24 hours of cleaning. Reclean the surface if more than 24 hours elapse before painting.

Apply at least 2.0 mils dry film thickness (DFT) of intermediate coating and at least 2.0 mils DFT of appearance coating.

Ensure that the appearance coating dries to form a smooth, continuous, tightly adhering film of uniform thickness and appearance, free of sags, runs, pinholes, holidays, overspray, and any other discontinuities; and that it has a uniform appearance within all portions of the painted piece and all related pieces and components of a job.

- F. Shop Cleaning and Painting.** Unless otherwise approved, do not apply coatings until all fabrication work is completed and has been tentatively accepted.

Follow all applicable provisions of AASHTO/NSBA Steel Bridge Collaboration S8.1, for both organic and inorganic zinc-based primer systems, except as modified by this Item. Use the paint systems specified in this Item and on the plans and meet the dry film thickness (DFT) requirements of this Item instead of those of S8.1. The requirement to test for primer curing using ASTM D 4752 does not apply to organic zinc primer. Use TxDOT Standard Test Method Tex-728-I instead of SSPC-PA2 for measuring DFT.

Repair all runs, sags, and other defects in each coat before application of subsequent coats.

Clean and paint surfaces that will be in contact with concrete, such as the top surfaces of top flanges, in accordance with the specified system except as modified in this Section or otherwise shown on the plans. Designate no-paint areas on the shop drawings.

Paint erection marks for field identification of members upon previously painted surfaces. Do not load pieces for shipment until coatings are thoroughly dry. Except for small approved touchups, do not apply any paint after material is loaded for shipment.

### 1. Faying Surfaces.

- a. Painted.** When painting faying surfaces, ensure that the primer used is documented to have the required slip and creep characteristics. If no mean slip coefficient (or corresponding surface condition) is specified, do not paint faying surfaces without approval.

Apply no more than the maximum average film thickness used in the qualifying test to the faying surfaces. Before bolting, ensure that paint on faying surfaces has cured for the minimum time used in the qualifying test. Perform all required testing of the paint at no additional expense to the City.

- b. Unpainted.** If surfaces to be in contact after final bolting will be left unpainted, provide an SSPC-SP 10 blast-cleaning, and ensure that these areas are free of paint and overspray to within 1 in. or 1 bolt diameter, whichever is less, from the outside edges of the bolt holes. Do not power wire-brush uncoated faying surfaces. Roughen galvanized faying surfaces by hand wire-brushing. Remove tape from masked areas as soon as practical.

For unpainted top lateral bracing connections shown on the plans as designed to AASHTO Class A surface condition (slip coefficient of 0.33), an SSPC-SP 10 blast-cleaning is not required. Remove grease and loose mill scale from nonweathering steel, and remove grease and all mill scale from weathering steel. If no slip

coefficient or assumed surface condition is shown on the plans or if the connection is shown as Class B (slip coefficient 0.50), provide an SSPC-SP 10 blast.

2. **No-Paint Areas at Field-Welded Connections.** Do not paint surfaces within 4 in. of groove welds or within 2 in. of fillet welds. Do not apply intermediate coat within 4 in. of the edge of primer at these areas. Remove tape from masked areas as soon as practical after painting.
3. **Paint Application for Specified Systems.**

- a. **System II.**

- (1) **Prime Coat.** Apply a total of 3.5 to 10.0 mils DFT of primer in at least 2 coats to outer surfaces that will not be in contact with concrete. Extend the primer at least 1½ in. onto surfaces that will be in contact with concrete, such as top flanges (see Figure 1). Coat the remaining portion of the surfaces to be in contact with concrete with a film coat of tightly adhering primer.
- (2) **Appearance Coat.** If the appearance coat is shop-applied, apply at least 2.0 mils DFT of appearance coating to outer surfaces that will not be in contact with concrete. Do not extend the appearance coat onto surfaces that will be in contact with concrete.

- b. **System III.**

- (1) **Outer Surfaces Not in Contact with Concrete.** Extend prime and intermediate coatings at least 1½ in. onto surfaces that will be in contact with concrete, such as top flanges (see Figure 2).
  - (a) **Prime Coat.** Apply at least 3.0 mils DFT of IOZ primer. Surfaces to be in contact with concrete may be covered with a film coat of IOZ primer. Thoroughly wet coated surfaces with a fine mist of potable water after the primer has set. Test the IOZ primer for cure in accordance with ASTM D 4752. If the IOZ primer meets a resistance rating of 4 or higher, apply the intermediate coat. If it does not meet this rating, reapply a fine mist of potable water until the coating is cured. Alternative cure tests may be used if recommended by the coating manufacturer.
  - (b) **Intermediate Coat.** Apply at least 2.0 mils DFT of epoxy intermediate coating after primer (including epoxy zinc on top flange; see 514.4.F.3.b(2), “Surfaces to be in Contact with Concrete”) has met curing requirements.
  - (c) **Appearance Coat.** If appearance coat is shop-applied, apply at least 2.0 mils DFT of appearance coating.
- (2) **Surfaces to be in Contact with Concrete.** See Figure 2. Before coating surfaces to be in contact with concrete, ensure that the IOZ prime coat has met curing requirements. Allow the surface to dry before evaluating the condition of the IOZ primer. If the surface to be in contact with concrete shows metal oxidation or if IOZ primer present on that surface is mud-cracked, reclean the surface to specified requirements. Do not damage the IOZ primer on other surfaces during recleaning. Paint on shear studs is not required. Apply 2 coats of 3 to 5 mils wet

film thickness (WFT) each of epoxy zinc primer to a clean, dry surface. Wait between 1 and 48 hours between coat applications.

**c. System IV.**

**(1) Outer Surfaces Not in Contact With Concrete.**

**(a) Prime Coat.** Apply at least 3.0 mils DFT of IOZ primer. Extend primer at least 1½ in. onto surfaces that will be in contact with concrete, such as top flanges (see Figure 3). Thoroughly wet all coated surfaces with a fine mist of potable water.

**(b) Appearance Coat.** If appearance coat is shop-applied, test the IOZ primer for cure in accordance with ASTM D 4752. If the IOZ primer meets a resistance rating of 4 or higher, apply the appearance coat. If it does not meet this rating, reapply potable water with a fine mist until the coating is cured. Alternative cure tests may be used if recommended by the coating manufacturer. Apply at least 2.0 mils DFT of appearance coating.

**(2) Surfaces to be in Contact with Concrete.** Coat surfaces to be in contact with concrete in accordance with Section 514.4.F.3.b(2), "Surfaces to be in Contact with Concrete."

**d. Paint Inside Tub Girders and Closed Boxes.** Provide an SSPC-SP 7 blast-cleaning to unpainted surfaces. Apply 2 to 3 mils DFT of paint over all inside surfaces that will be visible after final bolting including exposed surfaces of interior splice plates.

**e. Special Protection System.** Apply paint as shown on the plans.

**4. Repairs.** If repairs must be made after the IOZ primer has cured, use epoxy zinc primer to repair the IOZ primer. Brush application for touchup is acceptable as long as the paint is mixed in the appropriate proportions by weight and is agitated continuously during the painting operation.

**G. Field Cleaning and Painting.** Clean and paint only after erection or maintenance work including bolting, welding, straightening of material, etc. is complete; slab concrete has been placed; and the Engineer has examined and approved the work. Clean and paint unpainted areas including bolts, nuts, washers, and areas where the shop-applied paint has been damaged or fails to meet specification requirements, in accordance with the method required under the paint system specified. Prevent paint spatter and overspray from coming in contact with passing traffic, private and public property, and areas of the bridge not designated to be painted.

**1. Containment.** Submit a plan that details the procedures and type and size of equipment proposed to keep public property, private property, and the environment from being adversely affected by the cleaning and painting operations. Approval of the plan is required before cleaning and painting operations begin.

When required on the plans, submit an analysis showing the loads, including wind loads, added to the existing structure by the containment system and waste materials. Verify that the forces and stresses induced in the members from these loads do not cause them to be overstressed. Have a licensed professional engineer sign, seal, and date the submittal.

When abrasive-blasting is used to remove the existing coating, provide a containment system capable of containing all blast refuse. Unless otherwise shown on the plans, construct and maintain a structure meeting the following minimum requirements:

- rigid or flexible framing;
- ability to withstand winds up to 30 MPH;
- enclosure of all sides of area with air-penetrable or air-impenetrable walls;
- watertight floor;
- overlapping seams and entryways; and
- exhaust air filtration system capable of creating negative pressure inside the enclosure causing the sides of the containment to have a concave appearance.

In place of a full containment structure, a modified containment system may be proposed when using abrasive-blasting equipment equipped with negative pressure that will contain all blast refuse. Demonstrate for approval the equipment's ability to contain all blast refuse.

When using hand tools, provide a system that will contain all removed paint, rust, and other debris. Place an airtight membrane below the member being cleaned to collect all falling debris. When using power hand tools, equip them with high-efficiency particulate air (HEPA) filter vacuums or provide a full containment system as specified above.

When using water-blasting (low-pressure or high-pressure), provide a system capable of collecting all falling paint chips and other debris. Store, characterize, and dispose of all recovered debris in accordance with 30 TAC 335, "Industrial Solid Waste and Municipal Hazardous Waste." Discharge liquids in accordance with the TCEQ Texas Pollution Discharge Elimination Program (30 TAC 305, "Effluent Guidelines and Standards for TPDES Permits") and Texas Surface Water Quality Standards (30 TAC 307). Alternatively, liquids may be captured, stored and characterized for disposal at an authorized facility in accordance with 30 TAC 315, "Pretreatment Regulation for Existing and New Sources of Pollution," or 30 TAC 335, "Industrial Solid Waste and Municipal Hazardous Waste."

Remove all blast refuse from the floor and cleaned members before the Inspector enters the containment to inspect the cleaned surfaces. Remove all blast refuse from the containment before ending work for the day.

Provide containment during the priming operation to provide a wind-free environment and to keep the primer from entering the environment. Obtain approval of the containment system prior to beginning work.

Use a skimmer when cleaning and painting over bodies of water. If the skimmer collects any blast or paint material, remove the material the day the release occurs. Correct the containment problem that allowed the release before continuing work.

**2. Cleaning and Preparation of Surfaces.** Prepare surfaces prior to applying paint.

- a. General Preparation.** Clean far enough into the shop-applied paint to ensure removal of all contaminants. Feather edges of sound paint around cleaned areas.

Ensure that surfaces to be painted are completely free of oil, grease, moisture, dirt, sand, overspray, welding contamination (slag or acid residue); loose or flaking mill

scale, rust, or paint; weld spatter; and any other conditions that will prevent the paint from forming a continuous, uniform, tightly adhering film. Remove all steel splinters (hackles) raised or evident during cleaning. When abrasive blast-cleaning is required, reblast areas from which hackles are removed. Use the test described in Section 514.4.G.2.c, "Tape Test," on all surfaces to be painted to determine if they are contaminated with loose particles.

Before other cleaning operations, remove grease-like contaminants with clean petroleum solvents or other approved methods. Contain solvents and removed material as approved. Dispose of properly or reuse solvents as approved. This requirement applies to all coats.

When abrasive blast-cleaning is required, blast all flame-cut edges to produce a visible anchor pattern over the entire flame-cut surface.

Completely remove, as directed, the protective coating on machined surfaces and pins.

- b. Classes of Cleaning.** The requirements of Section 514.4.G.2.a, "General Preparation," apply whether or not a class of cleaning is specified. For blasting, use an approved abrasive as shown on the plans and potable water. Do not use steel shot. When abrasive blast-cleaning is used to remove existing paint containing lead or chromium, use an abrasive recycling system with an approved recyclable abrasive. Abrasive will be considered recyclable if it is separated from the dust and paint debris before being reused.
- (1) Class A Blast-Cleaning.** Remove all visible rust, paint, mill scale, and other forms of contamination, so that the blasted surface appears near white when viewed with the unaided eye (corrected to 20/20 vision). Slight staining is allowed provided it does not exceed 5% in any 9-sq. in. area. Staining includes light shadows, slight streaks, or minor discoloration caused by stains from rust, mill scale, or previously applied paint. Meet the surface preparation requirements of SSPC-SP 10 unless otherwise shown on the plans.
  - (2) Class B Blast-Cleaning.** Remove all dirt, rust scale, loose mill scale, loose rust, and loose paint. Tight mill scale and tightly adhered rust and paint are permitted. Expose each square inch of surface area to be cleaned to the abrasive blast pattern long enough to expose several flecks of the underlying metal. Meet the surface preparation requirements of SSPC-SP 7. Use the test described in Section 514.4.G.2.c, "Tape Test," on the cleaned surface to determine if it is adequately cleaned.
  - (3) Class C Cleaning.** Remove all exposed loose rust, loose mill scale, peeling or flaking paint, and oxidized paint. Clean these areas by hand-scraping, wire-brushing or other approved method. Feather all sound, tightly adhered coating edges surrounding cleaned areas.
  - (4) Class D Water-Blasting.** Remove all dirt, loose rust, and loose paint using water-blasting equipment. Tight mill scale and tightly adhered rust and paint are permitted. Probe perimeter of peeled areas of paint with a putty knife to ensure remaining paint is tightly adhered.

System I requires Class D water-blasting to remove contaminants, followed by a Class C cleaning for defective areas. If prime coat is field-applied, System II requires Class A blast-cleaning. If prime coat is shop applied, Systems II, III, and IV require Class A spot cleaning of all damaged and unpainted areas.

**c. Tape Test.** Perform the tape test as follows:

- Press a strip of filament tape onto the surface by rubbing with moderate thumb pressure 4 times, leaving approximately 2 in. of one end of the tape free from the surface.
- Grasp the free end and remove the tape from the surface with a sharp pull.

The surface will be considered to be contaminated and not adequately cleaned if visible particles cling to the tape.

**3. Painting.**

- a. Paint Condition.** Thoroughly mix and strain paints to be applied. Mix by mechanical methods. Ensure that the paint is a completely homogeneous mixture free of lumps, skins, and agglomerates and that it contains all pigments, vehicle solids, and thinners required in the original formulation. Keep paint containers tightly covered and protected from weather when not in use.
- b. Thinning.** Adjust paint to the correct application consistency by using suitable thinners or by using properly applied heat up to 150°F. Using heat to thin epoxy paints may decrease their useful pot life.
- c. Paint System Requirements.** Ensure that all coatings in the paint system, including shop-applied coats, are from the same manufacturer.

**(1) System I (Overcoating).**

- (a) Penetrating Sealer.** Apply at least 1.0 mil DFT of penetrating sealer to all surfaces to be painted.
- (b) Prime Coat.** Apply at least 4.0 mils DFT of primer to areas that have received a Class C cleaning and to other areas where there is no existing primer.
- (c) Appearance Coat.** Apply at least 2.0 mils DFT of appearance coat.

**(2) System II.**

- (a) Prime Coat.** Apply 3.5 to 10.0 mils DFT of primer in at least 2 coats.
- (b) Appearance Coat.** Apply at least 2.0 mils DFT of appearance coat.

**(3) Systems III.**

- (a) Prime Coat.** Spot-clean to Class A all damaged and unpainted areas. Apply at least 3.0 mils DFT of epoxy zinc primer to the cleaned areas.

**(b) Intermediate Coat.** If intermediate coat is not shop applied, apply at least 2.0 mils DFT of epoxy intermediate coating.

**(c) Appearance Coat.** Apply at least 2.0 mils DFT of appearance coat.

**(4) System IV.**

**(a) Prime Coat.** Spot-clean to Class A all damaged and unpainted areas. Apply at least 3.0 mils DFT of epoxy zinc primer to the cleaned areas.

**(b) Appearance Coat.** Apply at least 2.0 mils DFT of appearance coat.

**(5) Special Protection System.** Apply paint as shown on the plans.

- d. Temperature.** Do not apply #810 Prime Coat when the steel or air temperature is below 50°F or when the steel or air temperature is expected to drop below 50°F within 2 hr. after application. Do not apply #742 Appearance Coat when the steel or air temperature is below 40°F or when the steel or air temperature is expected to drop below 40°F within 2 hours after application. Follow product data sheets for temperature requirements for all other paints.
- e. Application.** Immediately before painting, clean steel surfaces or surfaces of previously applied coats of paint by blowing with clean compressed air, brushing, or both to remove traces of dust or other foreign particles. When directed, wash the surfaces of previously applied coatings either with clean, fresh water or with a mild detergent and water mixture followed by a complete and thorough rinse with clean, fresh water. Do not apply paint to any surface with discernible moisture.

Do not apply paint to any surface when the relative humidity is greater than 85% as determined by a sling psychrometer in accordance with ASTM E 337. Do not apply any paint when impending weather conditions might result in injury to fresh paint.

Do not apply paint to any surface when the relative humidity is greater than 85% as determined by a sling psychrometer in accordance with ASTM E 337.

Apply each coat of paint to clean, dry, firm surfaces complying with all specification requirements. Ensure that surfaces to be painted are free of all forms of contamination. Ensure that each coat dries to form a smooth, continuous, tightly adhering film of uniform thickness and appearance, free of sags, runs, pinholes, holidays, overspray, or other defects. Apply all coats by spray, except that any approved method of application may be used to paint inaccessible areas.

Repair all runs, sags, and other defects in each coat of paint before application of subsequent coats.

Measure the dry film thickness of coatings in accordance with TxDOT Standard Test Method Tex-728-I.

If, in the opinion of the Engineer, there is an objectionable amount of dust in the atmosphere, discontinue painting or take necessary precautions to prevent dust and dirt from coming in contact with freshly painted surfaces or with surfaces before the paint is applied.

Where there is potential for paint to be sprayed on traffic, provide a shield that will protect the traffic from paint.

When painting steel that is in contact with concrete, provide full coverage of the steel with a minimal amount of paint on the concrete surface. Do not extend the paint more than 4 in. onto the concrete surfaces or as directed. Ensure that when painting is complete, the only visible paint on concrete surface is the finish coat. Remove excessive or objectionable paint on concrete surfaces in an approved manner.

**(1) Prime Coat.** Paint cleaned areas with the specified prime coat. Overlap painting onto the surface of the shop applied paint enough to form a sealed edge.

When System III or IV is specified, paint spot-repair and unpainted areas with epoxy zinc primer. Cure the epoxy zinc primer in accordance with the manufacturer's product data sheet before applying appearance coat.

When System II is specified and the steel and the ambient temperature are both above 60°F, the second coat of primer may be applied before the first coat has cured but not within 2 hours after the application of the first coat. Cure the primer in accordance with Table 1 before applying appearance coat.

**Table 1**  
**System II Primer Cure Times**

<b>Temperature</b>	<b>Day Cure, Minimum</b>
77°F and above	2
65 to 77°F	3
55 to 65°F	4
40 to 55°F	5

**(2) Appearance Coat.** After field-painting of the prime coat in accordance with Section 514.4.G.3.e(1), "Prime Coat," is completed and approved, apply the specified appearance coat.

Clean prime coat and intermediate coat surfaces by an approved method which does not damage the paint to remove all dirt, grease, concrete, overspray, and any other substance that may impair adhesion before the application of the appearance coat.

Provide an even and uniform appearance throughout the painted portion of the structure.

- f. Workmanship.** Perform all painting with skilled painters who can adjust equipment and application techniques as dictated by the type of paint, weather conditions, environment, and size and shape of the surface being painted. Painters who, in the opinion of the Engineer, do not adjust equipment to apply coatings in a uniform full wet coat free of runs, sags, holidays, and overspray will not be considered skilled painters.

Apply sprayed coatings essentially 90° to the surface and between 10 and 18 in. from the surface as necessary to apply a full wet coat of paint free of overspray, runs, sags, and holidays. Any spray painter who does not consistently spray in this manner or extends the spraying stroke so that paint is applied to the surface at an angle of less

than 80° will not be allowed to spray paint. Brush application for touchup is acceptable as long as the paint is mixed in the appropriate proportions by weight and is agitated continuously during the painting operation.

4. **Handling and Shipping.** Pad the blocks, chains, slings, braces, clamps, etc., used for handling, moving, storing, and shipping painted members so that the paint will not be damaged.
  5. **Cleaning and Painting Existing Structures.** Unless otherwise shown on the plans, provide System II for existing steel structures to be cleaned and painted.
- H. Paint Improperly Applied.** To uncover evidence of improperly applied paint, the Engineer may at any time during construction explore underneath the surface of any paint coats already applied. Repair these areas of investigation at no additional expense to the City. Whenever unsatisfactory conditions are found, the Engineer may require remedial measures.

Repair or completely remove and replace all paint that has been applied improperly, has been applied to improperly cleaned surfaces, fails to dry and harden properly, fails to adhere tightly to underlying metal or other paint film, or does not have a normal, workmanlike appearance in conformance with this Item. When the final field coat does not have a uniform color and appearance throughout the structure, correct it by the use of whatever additional coats or other corrective measures are required. Remove freshly applied paint that has not yet set with the use of suitable solvents. Remove dried paint films with blast-cleaning, scraping, or flame torches, as approved.

- I. Storage and Disposal.** Collect all waste generated by cleaning and painting operations as necessary to prevent release into the environment. At a minimum, collect all waste before leaving the job site each day. Handle and store the waste as if it were hazardous until classification is made. Follow the requirements of 30 TAC 335 for onsite handling of the waste. Store waste collected in containers that comply with 49 CFR 178. Seal containers containing waste each day before leaving the job site.

Test each container of waste using EPA Test Method 1311, "Toxicity Characteristic Leaching Procedure (TCLP)," to determine existing metal and organic content. If testing shows that the waste is not hazardous, handle and dispose of the waste as a "Special Waste" as defined in 30 TAC 330.2 or as directed. Provide documentation showing that disposal of the waste was done in a suitable landfill holding permits to handle this type of material. If testing shows that the waste is hazardous, dispose of the waste in compliance with applicable hazardous waste rules and regulations. Transport hazardous waste using a permitted transporter and dispose of in an authorized hazardous waste facility.

When the plans specify that the existing coating to be removed contains hazardous materials and steel grit is used as the abrasive, the waste generated is classified as hazardous regardless of the results of the TCLP. Dispose of this waste in compliance with applicable hazardous waste rules and regulations as specified above and by the Contract.

Provide copies of all test reports and transportation manifests to the Engineer before shipping hazardous waste. Provide signed original manifests to the Engineer verifying that all steps of the handling and disposal process were correctly handled.

- J. Miscellaneous.** Notify the Engineer of any condition that may require the repair or replacement of any portion of the bridge.

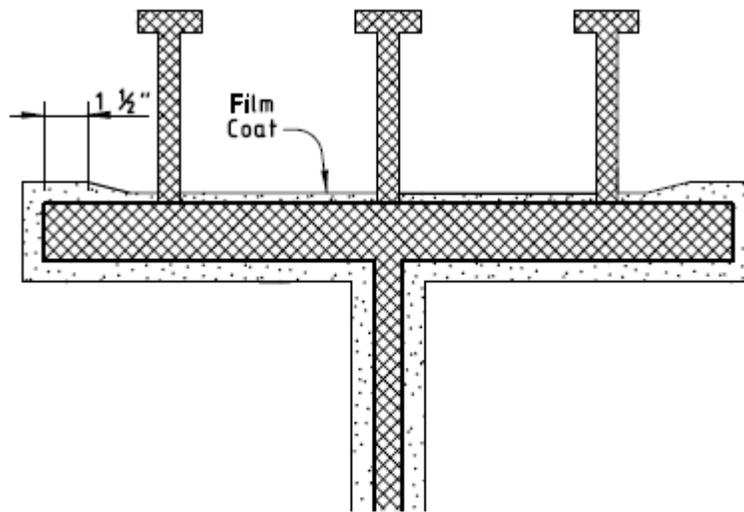
Upon completion of the painting operations for each structure that will be considered by TxDOT as “On-System,” stencil on the exterior face of the outside beam the control, section, and structure number, as directed. Stencil on the interior face of the outside beam the completion date of the painting operation. Do this work at each end of the structure where painting is specified.

**514.5. MEASUREMENT:** “Paint and Painting” will not be measured for payment.

**514.6. PAYMENT:** The work and materials prescribed herein will not be paid for directly, but shall be included in the unit bid price for the items of construction in which this work and materials are used.

**514.7. BID ITEM:**

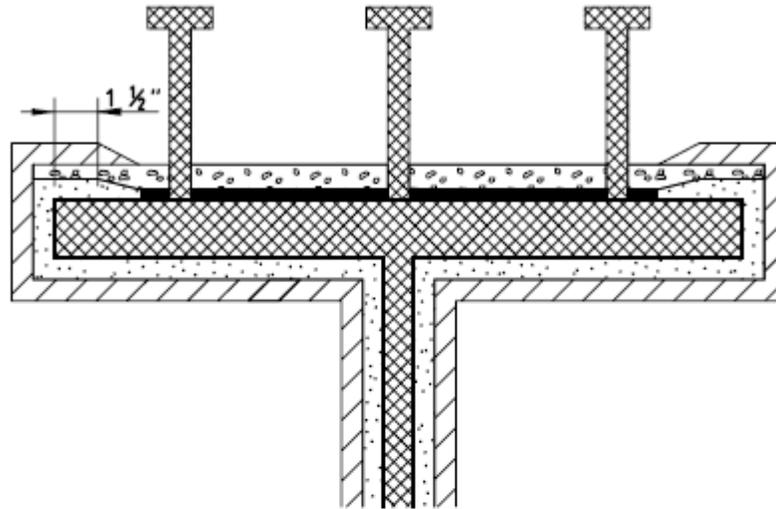
N/A



-  System II Primer
-  Steel Girder and Shear Stud

**Figure 1**  
**Application areas of System II paint (appearance coat not shown).**

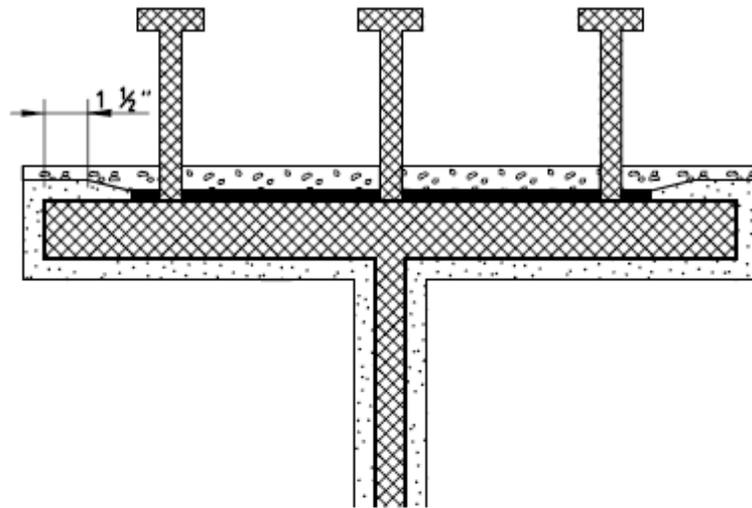
**From Texas Department of Transportation**



- System III IOZ Primer Film Coat (Optional)
- System III IOZ Primer
- ▨ System III Epoxy Zinc Primer
- ▧ System III Epoxy Intermediate
- ⊠ Steel Girder and Shear Stud

**Figure 2**  
**Application areas of System III paints (appearance coat not shown).**

**From Texas Department of Transportation**



- System IV IOZ Primer Film Coat (Optional)
- ▨ System IV IOZ Primer
- ▩ System IV Epoxy Zinc Primer
- ⊠ Steel Girder and Shear Stud

**Figure 3**  
Application areas of System IV paints (appearance coat not shown).

From Texas Department of Transportation

**ITEM****526 FIELD OFFICE**

**526.1. DESCRIPTION:** *This item shall govern the erection or furnishing of a building to be used by the inspection force as a Field Office where the contract amount is one million dollars or greater.*

**526.2. EQUIPMENT:**

- A. General.** Furnish facilities after the receipt of the work order to begin work and before beginning physical work on the project. Provide field offices of the type and number specified near the worksite at a location acceptable to the Engineer. The Contractor may make use of permanent buildings or rental space meeting the requirements for field offices instead of portable buildings if approved. Maintain the field office until the City accepts the project. Furnish other equipment as required.
- B. Damage.** Immediately repair or replace the facility if it is damaged in any manner. Payment for repair will not be made unless it is the result of negligence by the City. Reimburse the City for equipment damaged by the Contractor's operations.
- C. Right-Of-Way.** When facilities are allowed in the right of way, remove buildings and other facilities and restore the right of way before project acceptance.
- D. Parking and Fencing.** Unless otherwise shown on the plans, provide an all-weather parking area for the sole use of at least 2 City-owned vehicles. Situate the area near the field office or laboratory at a location acceptable to the Engineer. Maintain the parking area until the project is completed and restore the area to a condition acceptable to the Engineer upon project completion. When shown on the plans, enclose the field office or laboratory and the parking area with a 6-ft. chain-link fence, a top-mounted 3-strand barbed wire, and a 12-ft. gate.
- E. Buildings.**
  - 1. Field Office.** Provide field offices with roofs, floors, doors, and screened windows. The building shall be a minimum of 10 feet by 16 feet by 8 feet high with not less than three glass windows and one door. Ensure the floor is of sufficient strength to support testing equipment and has an impervious floor covering.

If the Contractor uses part of the structure, do not interconnect the field office with Contractor-used rooms.

Ensure that the field office is weatherproof, piped for water and fuel, and electrically wired by certified personnel with the power requirements shown on the plans or directed by the Engineer. Furnish and install adequate equipment, outlets, lighting, air conditioning, heating, and ventilation.

Provide a partitioned rest room furnished with rest room supplies, a lavatory and a flush toilet connected to a sewer or septic tank. A portable toilet may be used when approved by the Engineer.

When directed by the Engineer, provide secured and controlled access to the field office or laboratory through the use of security measures such as bars, alarms, or security fencing. Furnish steps to the building if deemed necessary by the Engineer.

- 2. Laboratory.** Provide laboratories with all of the requirements described in Section 526.2.E.1, "Field Office." In addition, provide the following items unless otherwise directed:
- a. laboratory equipment necessary for testing when shown on the plans;
  - b. water (for testing purposes) from an approved source;
  - c. an exhaust fan for concrete curing, asphalt, or other operations to meet OSHA requirements (Vent all exhaust to the outside of the structure.);
  - d. a work platform at least 18 in. long and 12 in. wide, mounted on a lumber post at least 6 in. by 6 in. extending through the floor and firmly fixed in the ground (The work platform support can be provided by other methods as shown on the plans or as directed.);
  - e. a minimum of 20 ft. of total work counter length at least 3 ft. wide and 3 ft. above the floor and of sufficient strength to support required testing equipment;
  - f. and a laboratory sink measuring 24 in. by 30 in. and 12 in. in depth.
- F. Field Office and Laboratory Appurtenances.** Provide workbenches and tables at least 3 ft. wide and 6 ft. long, chairs, and filing cabinets in the quantity acceptable to the Engineer. Provide solar screens, blinds, or shades if deemed necessary by the Engineer. Provide potable water, electricity, collection and disposal of trash, and janitorial services acceptable to the Engineer.

Provide a telephone and service unless otherwise directed. A cell phone may be provided to meet this requirement. Provide a paper copier and facsimile when required by the plans.

For Contracts that require a nuclear gauge for moisture or density determination, provide a closet within the facility or a separate structure for storage of the gauge as far as possible from the normal office work. For all doors allowing access to the nuclear gauge, provide internal keyed deadbolt locks and hinges with pins on the inside of the storage area.

When shown on the plans provide any or all of the following in accordance with the requirements therein:

- computers (laptop or desktop) meeting the minimum requirements of Item 1000, "Web Portal" or as designated on the plans,
- printers, and
- Internet service. The Internet service must be a provided on a line separate from required phone service.

**526.3. MEASUREMENT:** No measurement will be made under this item.

**526.4. PAYMENT:** No payment will be made under this item. The Field Office is not a pay item and shall remain the property of the contractor after completion of this project.

**526.5. BID ITEM:**

N/A

## ITEM

### 530 BARRICADES, SIGNS, AND TRAFFIC HANDLING

**530.1. DESCRIPTION:** *This item shall govern for providing, installing, moving, repairing, maintaining, cleaning and removing upon completion of work, all barricades, signs, cones, lights and other such type devices and of handling traffic as indicated on the plans or as directed by the Engineer.*

**530.2. GUIDELINES FOR BARRICADING ON CITY RIGHT-OF-WAY:** The barricade contractor must locally maintain sufficient materials in stock to accommodate three or more construction phases per project. These will include all applicable traffic control sign types, trucks, trailers, arrow boards, and all other traffic control devices assigned to the Contractor's barricading operation.

The *Texas Manual on Uniform Traffic Control Devices (TMUTCD)*, Section 6A-6, requires the appropriate training for all personnel who are involved in the selection, placement, and maintenance of traffic control devices on construction projects. The City of San Antonio requires that all personnel associated with barricading operations and traffic handling possess certificates from either of the two groups listed in Table 1 below. Each certificate will be valid for four years.

**Table 1  
Barricading Training**

Texas Engineering Extension Service	American Traffic Safety Service Association
Work Zone Traffic Control	Training Course for Worksite Traffic Supervisors

The Contractor shall have a minimum of one barricade supervisor and three persons who are responsible for construction work zone traffic control. These persons shall be based in the San Antonio metropolitan area and their sole tasks shall be implementing and maintaining construction work zone traffic control devices.

The Contractor shall have a commercial telephone answering service during non-working hours. The Contractor shall provide the City during working hours with an office telephone number, pager number, and cellular telephone number to contact the barricading supervisor. The contractor must be able to respond to any call within two hours. The barricading contractor or General Contractor must possess liability insurance in the minimum amount of one million dollars. A copy of the liability policy must be sent to the City Traffic Engineer for approval 48 hours prior to starting barricading operations.

The contractor shall comply with all standards set forth in the plan barricade detail sheets. One noncompliance letter issued by the City to the Contractor in regard to construction work zone traffic control, and not corrected within 48 hours, will be cause for delay of payment for this item.

If the general contractor elects to do his own barricading, he must comply with all the foregoing requirements. Additionally, a general contractor will be required to submit a traffic control plan (TCP) at least 72 hours in advance (excluding weekends and holidays) of starting work in each construction phase. Upon satisfactory evidence of competent barricading expertise, this requirement for a traffic control plan may be waived by the City Traffic Engineer.

**530.3. EQUIPMENT:** Provide the machinery, tools and equipment necessary for proper prosecution of the work. All machinery, tools and equipment used shall be maintained in a satisfactory and workmanlike manner.

**530.4. CONSTRUCTION:** All barricades, signs, and other types of devices listed above shall conform to the requirements of the TMUTCD. It is the contractor's responsibility to see that all traffic control devices are properly installed and maintained at the job site. If it is determined by the Traffic Engineering Representative that the traffic control devices do not conform to the established standards, or are incorrectly placed to protect the general public, the Traffic Engineer shall have the option to stop the work, at no expense to the City, until the situation is corrected by the Contractor. If it is determined that additional temporary traffic control devices, special directional devices, and/or business name signs are required, they will be provided by the contractor at no additional cost. As work progresses, the location of temporary traffic control devices will be adjusted and modified as necessary by the Contractor.

All retro reflective traffic control devices such as barricades, vertical panels, signs, etc., shall be maintained by cleaning, replacing or a combination thereof such that during darkness and rain, the retro reflective characteristics shall equal or exceed the retro reflective characteristics of the standard reflective panels in the Inspector's possession.

The contractor shall contact the City of San Antonio Traffic Operations Section prior to removing any traffic signs or traffic signals. Prior to completion of the contract and removal of barricades, all applicable permanent traffic signs and signals must be in place and functioning properly. All permanent signs or traffic control devices missing or damaged during construction shall be replaced at the contractor's expense. Permanent pavement marking shall be applied prior to the opening of any street to traffic. Temporary short-term expendable pavement markings may be provided prior to application of permanent markings.

The contractor must maintain all streets open to through traffic by repairing trenches, potholes, etc., at no direct payment. The contractor shall provide reasonable access to residences and all businesses within all phases of the work, as well as providing suitable access accommodations for school children, pedestrians, garbage pick-up and mail delivery by the US Postal Service. Temporary pedestrian crossing will be determined in the field by the Police Department School Services Unit. Temporary pedestrian crossings shall be 4 feet wide by 4 inches thick asphalt treated base or asphaltic concrete and will be paid for under Item 206, "Asphalt Treated Base" or Item 205, "Hot Mix Asphaltic Concrete Pavement," respectively.

When flagging is required by the plans or Traffic Control Plan, provide a Contractor representative who has been certified as a flagging instructor through courses offered by the Texas Engineering Extension Service, the American Traffic Safety Services Association, the National Safety Council, or other approved organizations. Provide the certificate indicating course completion when requested. This representative is responsible for training and assuring that all flaggers are qualified to perform flagging duties. A qualified flagger must be independently certified by one of the organizations listed above or trained by the Contractor's certified flagging instructor. Provide the Engineer with a current list of qualified flaggers before beginning flagging activities. Use only flaggers on the qualified list.

Flaggers must be courteous and able to effectively communicate with the public. When directing traffic, flaggers must use standard attire, flags, signs, and signals and follow the flagging procedures set forth in the TMUTCD.

**530.5. MEASUREMENT:** This item will be measured by "Lump Sum" as indicated on the plans.

**530.6. PAYMENT:** This item will be paid for at the contract lump sum price bid for “barricades, signs, and traffic handling”. This price shall be full compensation for furnishing all labor, materials, supplies, equipment and incidentals necessary. To complete the work as specified. The lump sum price will be pro-rated based on the number of workdays in the project contract. Failure to complete the work within time allowed in the project contract due to approving designs, testing, material shortages, closed construction season, curing periods, and testing periods will not qualify for additional compensation. When additional work is added by an approved field alteration or when work is suspended for the convenience of the City, through no fault of the contractor, additional compensation may be paid to the Contractors.

**530.7. BID ITEM:**

Item 530.1 - Barricades, Signs and Traffic Handling - lump sum

**ITEM****533 CLEANING AND REMOVAL OF PAVEMENT MARKINGS AND MARKERS**

- 533.1. DESCRIPTION:** *Clean both concrete and asphaltic surfaces prior to the placement of pavement markings/markers and/or for removal of existing pavement markings and raised pavement markers.*
- 533.2. MATERIALS:** The blasting medium shall be a quality commercial product capable of producing the specified surface cleanliness without the deposition of deleterious materials on the cleaned surface.
- 533.3. EQUIPMENT:** All equipment shall be of sufficient capacity to efficiently and economically clean the roadway surface to the specified cleanliness. Equipment shall be power driven and in good operating condition. Equipment shall utilize moisture and oil traps, in working order, of sufficient capacity to remove contaminants from the air and prevent deposition of moisture, oil or other contaminants on the roadway surface.
- 533.4. CONSTRUCTION:** Unless otherwise shown on the plans, acceptable methods of removal for asphaltic pavements include heat scarification, blasting, and mechanical methods. Grinding is not an acceptable mechanical method unless otherwise approved by the Engineer. Blasting is the only acceptable method for removal or cleaning of a portland cement concrete surfaced pavement.

**A. Removal of Existing Pavement Markings/Markers.**

1. Existing markings or markers to be removed shall be removed to the extent that the pavement marking or marker and its adhesive compound is/are either completely removed or obliterated.
2. Widths, lengths, and shapes of the cleaned surface shall be of sufficient size to include the full area of the specified pavement marking to be placed or removed.
3. Avoid damage to the pavement surface during the removal of markings or markers. Repair damaged areas on asphaltic surfaces in excess of ¼ inch in depth using approved patching materials.
4. Blasting on portland cement concrete surfaces shall be sufficient to remove old pavement markings and all other contaminants. Over-blasting to the extent of damage to the roadway surface shall be avoided.
5. Very small particles of tightly adhering existing markings may remain in place if complete removal of the small particles will result in pavement damage.

**B. Cleaning.**

1. Pavement surfaces where existing pavement markings will remain in place shall be cleaned with high pressure air or water to remove dust, sand, and other objectionable material prior to application of new markings. If water is used, the area to be cleaned shall be sufficiently dry, as defined in Item 535.4.A.1, for application of the marking material.

2. All surfaces other than portland cement concrete surfaces required to be cleaned shall be cleaned sufficiently to remove loose and flaking conditions or markings of the road surface. Surface cleaning shall be completed on all existing pavements where the inlaid plastic material or raised pavement marker is not being used with new pavement.
  3. Where blasting is used for the removal of pavement markings, adhesives, or for removal of objectionable material, remove the residue, including dust and water, immediately after contact with the surface being treated. Remove by a vacuum attachment operating concurrently with the blasting operation.
  4. Where grinding is allowed by the Engineer to remove pavement markings on asphaltic concrete pavements, remove the residue by means of a vacuum attachment to the grinding machine. Do not allow the residue to flow across or be left on the pavement.
- 533.5. MEASUREMENT AND PAYMENT:** Cleaning or removal of existing or incorrectly installed pavement markings and/or markers shall not be paid for directly, but shall be considered subsidiary to the pavement marking or marker items or Mobilization if no pavement marking pay items are used.
- 533.6. BID ITEM:** This specification is included solely as a technical guide as to how cleaning or removal of markings and/or markers shall be performed and does not constitute a separate bid item.

## ITEM

### 535 HOT APPLIED THERMOPLASTIC PAVEMENT MARKINGS

- 535.1. DESCRIPTION:** *Apply thermoplastic pavement markings, in conformance with the minimum optical and physical properties required for a thermoplastic road marking compound described herein, in a molten state, onto a pavement surface.*
- 535.2. MATERIALS:** All materials shall conform to the requirements of TxDOT DMS-8220 “Hot Applied Thermoplastic.” Thermoplastic materials shall be stored in a dry environment to minimize the amount of moisture retained during storage.
- 535.3. EQUIPMENT:** Provide the necessary equipment to conduct the work specified herein. All equipment shall be maintained in good working order such that neat and clean thermoplastic markings are applied at the proper thicknesses and glass beads are placed at the correct rate. Equipment that is deemed deficient by the Engineer shall be replaced immediately.
- 535.4. CONSTRUCTION:** The appearance of the finished markings shall have a uniform surface, crisp edges with a minimum over-spray, clean cut-off, meet straightness requirements and conform to the design drawings and/or engineer instructions.

The contractor shall provide the Engineer with certification from the marking manufacturer that contractor has been adequately trained and certified to apply the manufacturer's material. This certification shall be considered current if the certification date provided by the manufacturer is within two years of the date of marking application.

All striping and pavement markings shall be placed in accordance with the requirements of this specification, the detailed plans, and the current edition of the *Texas Manual on Uniform Traffic Control Devices* (TMUTCD). The Contractor shall provide all other engineering services necessary for pre-marking of all proposed stripe within the limits of the designated work.

Unless authorized otherwise in writing by the Engineer, striping shall be accomplished during daylight hours. Approved lighting arrangements will be required for night time operations when allowed.

The Contractor may be required to place markings over existing markings, as determined by the Engineer. The contractor shall adjust the operation of the thermoplastic screed shoe to match the previous lengths of stripes and skips, when necessary.

Failure of the striping material to adhere to the pavement surface during the life of the contract shall be prima facie evidence that the materials, even though complying with these specifications, or the application thereof, was inconsistent with the intent of the requirements for the work under the latest City specifications and shall be cause for ordering corrective action or replacement of the marking without additional cost to the City.

Unless otherwise approved by the Engineer, permanent pavement markings on newly constructed pavements surfaced with asphaltic concrete or bituminous seals shall not be applied for a minimum of 14 days or a maximum 35 days. Temporary pavement marking shall be provided during the 14 to 35 day period.

### A. Surface Preparation.

1. **Moisture.** All surfaces shall be inspected for moisture content prior to application of thermoplastic. Approximately two square feet of a clear plastic or tar paper shall be laid on the road surface and held in place for 15 to 20 minutes. The underside of the plastic or tar paper shall then be inspected for a buildup of condensed moisture from the road surface. Pavement is considered dry if there is no condensation on the underside of the plastic or tarpaper. In the event of moisture, this test shall be repeated until there is no moisture on the underside of the plastic or tar paper.
2. **Cleaning.** All surfaces shall be clean and dry, as defined in Section 535.4.A.1, before thermoplastic can be applied. Loose dirt and debris shall be removed by thoroughly blowing compressed air over the area to be striped. If the thermoplastic is to be applied over existing paint lines, the paint line shall be swept with a mechanical sweeper or wire brush to remove poorly adhered paint and dirt that would interfere with the proper bonding or the thermoplastic. Additional cleaning through the use of compressed air may be required to remove embedded dirt and debris after sweeping. Latence and curing compound shall be removed from all new portland cement concrete surfaces in accordance with Item 533, "Removal of Pavement Markings and Markers."
3. **Layout.** The pavement markings shall be placed in proper alignment with guidelines established on the roadway. Deviation from the alignment established shall not exceed 2 inches and, in addition, the deviation in alignment of the marking being placed shall not exceed 1 inch per 200 feet of roadway nor shall any deviation be abrupt.

No striping material shall be applied over a guide cord; only longitudinal joints, existing stripes, primer, or other approved type guides will be permitted. In the absence of a longitudinal joint or existing stripe, the Contractor shall mark the points necessary for the placing of the proposed stripe. Edge striping shall be adjusted as necessary so that the edge stripe will be parallel to the centerline and shall not be placed off the edge of the pavement.

Longitudinal markings shall be offset at least 2-inches from construction joints of portland cement concrete surfaces and joints and shoulder breaks of asphalt surfaces.

4. **Primer Sealer.** Primer sealer shall be used on all portland cement concrete surfaces. A primer sealer shall be used on asphalt surfaces that are over two years old and/or on asphalt surfaces that are worn or oxidized to a condition where 50 percent or more of the wearing surface is exposed aggregate. Existing pavement markings may act as the primer sealer if, after cleaning, more than 70 percent of the existing pavement marking is still properly bonded to the asphalt surface (see coverage check procedure in Appendix A to estimate percent of marking remaining).
5. **Primer Sealer Application.** When required as described, the primer-sealer shall be applied to the road surface in a continuous film at a minimum thickness of 3 to 5 mils. Before the Thermoplastic is applied, the primer-sealer shall be allowed to dry to a tacky state. The thermoplastic shall be applied within 4 hours after the primer application.

### B. Temperature Requirements.

1. **Ambient Conditions.** The ambient air and road surface shall be 55°F and rising before application of thermoplastic can begin.

2. **Material Requirements.** Unless otherwise specified by the material manufacturer, the thermoplastic compound shall be heated from 400°F to 450°F and shall be a minimum of 400°F as it makes contact with road surface during application. An infrared temperature gun shall be used to determine the temperature of the thermoplastic as it is being applied to the road surface.

### C. Drop-on Glass Sphere Application.

1. **Application Rate.** Retro-reflective glass spheres shall be applied at the rate of 10 pounds per 100 square feet of applied markings. This application rate shall be determined by confirming the following consumption rates:
  - a. 200 pounds of drop on glass spheres per ton of applied thermoplastic when the thermoplastic is being applied at 0.090 inch film thickness.
  - b. 150 pounds of drop on glass spheres per ton of applied thermoplastic when the thermoplastic is being applied at 0.125 inch thickness.
2. **Application Method.** Retro-reflective glass spheres shall be applied by a mechanical dispenser properly calibrated and adjusted to provide proper application rates and uniform distribution of the spheres across the cross section of the entire width of the line. To enable the spheres to embed themselves into the hot thermoplastic, the sphere dispenser shall be positioned immediately behind the thermoplastic application device. This insures that the spheres are applied to the thermoplastic material while it is still in the molten state.

### D. Application Thickness.

1. **Longitudinal and Transverse Markings.** On previously unmarked pavements or pavements where markings have been effectively removed, all lane lines, center lines, transverse markings and pavement markings in traffic areas with  $\leq 1,000$  vehicles per day per lane shall have a minimum film thickness of 0.090 inch at the edges and a maximum of 0.145 inch at the center. A minimum average film thickness of 0.090 inch shall be maintained. On pavements with existing markings, meeting the traffic requirements stated above, all lane lines, center lines, transverse markings and pavement markings shall have a minimum film thickness of 0.060 inch for re-application over existing strip line.
2. **High Wear Longitudinal and Transverse Marking.** On previously unmarked pavements or pavements where markings have been effectively removed, all lane lines, center lines, transverse markings and pavement markings in high traffic areas ( $>1,000$  vehicles per day per lane) shall have a minimum film thickness of 0.125 inch at the edges and a maximum of 0.188 inch at the center. A minimum average film thickness of 0.125 inch shall be maintained. On pavements with existing markings, meeting the traffic requirements stated above, all lane lines, center lines, transverse markings and pavement markings shall have a minimum film thickness of 0.090 inch for re-application over existing strip line.

### E. Packaging.

1. **Containers.** The thermoplastic material shall be delivered in 50 pound containers or bags of sufficient strength to permit normal handling during shipment and handling on the job without loss of material.
2. **Labeling.** Each container shall be clearly marked to indicate the color of the material, the process batch number and/or manufacturer's formulation number, the manufacturer's name and address and the date of manufacture.

**F. Acceptance.**

1. **Sampling Procedure.** Random samples may be taken at the job site at the discretion of the City Engineer for quality assurance. The City reserves the right to conduct the tests deemed necessary to identify component materials and verify results of specific tests indicated in conjunction with the specification requirements.

The sample(s) shall be labeled as to the shipment number, lot number, date, quantity, and any other pertinent information. At least three randomly selected bags shall be obtained from each lot. A 10 pound) sample from the three bags shall be submitted for testing and acceptance. The lot size shall be approximately 44,000 pounds unless the total order is less than this amount.

2. **Manufacturer's Responsibility.**

- a. **Sampling and Testing.** The manufacturer shall submit test results from an approved independent laboratory. All material samples shall be obtained 20 days in advance of the pavement marking operations. The cost of testing shall be included in the price of thermoplastic material. The approved independent laboratory's test results shall be submitted to the City Traffic Engineer in the form of a certified test report.

- b. **Bill of Lading.** The manufacturer shall furnish the Material and Tests Laboratory with copies of Bills of Lading for all materials inspected. Bill of lading shall indicate the consignee and the destination, date of shipment, lot numbers, quantity, type of material, and location of source.

- c. **Material Acceptance.** Final acceptance of a particular lot of thermoplastic will be based on the following.

- (1) Compliance with the specification for material composition requirements verified by approved independent laboratory with tests results.

- (2) Compliance with the specification for the physical properties required and verified by an approved independent laboratory with test results.

- (3) Manufacturer's test results for each lot thermoplastic have been received.

- (4) Identification requirements are satisfactory.

3. **Contractor's Responsibility.**

- a. **Notification.** The contractor shall notify the Construction Inspector 72 hours prior to the placement of the thermoplastic markings to enable the inspector to be present during the application operation. At the time of notification, the Contractor shall indicate the manufacturer and the lot numbers of the thermoplastic that will be used.

A check should be made by the contractor to insure that the approved lot numbers appear on the material package. Failure to do so is cause for rejection.

- b. Warranty or Guarantee.** If the normal trade practice for manufacturers is to furnish warranties or guarantees for the materials and equipment specified herein, the Contractor shall turn the guarantees and warranties over to the Engineer for potential dealing with the manufactures. The extent of such warranties or guarantees will not be a factor in selecting the successful bidder.

**535.5. MEASUREMENT:** Measurement shall be based on the length of satisfactorily installed line, in feet, or as appropriate, the number of symbols or words which are satisfactorily installed on the roadway surface by the contractor.

**535.6. PAYMENT:** Payment shall be according to the quantities measured for each bid item.

**535.7. BID ITEM:**

Item 535.1 - N/A

Item 535.2 - 4 inch wide white line

Item 535.3 - N/A

Item 535.4 - N/A

Item 535.5 - 12 inch wide yellow line

Item 535.6 - N/A

Item 535.7 - 24 inch wide white line

N/A

### APPENDIX A: Method for Estimating Amount of Marking Bonded to Pavement

This inspection will ensure uniformity of coverage of the entire line, such as paint cracking, peeling, and whether or not the marking has adequate coverage. One-square-inch sections of transparent material inscribed within a grid of 100 equal squares shall be used as a tool for quantitative measure of specified percentage of coverage. The grid concept was taken from the Air Force who used it for measuring rubber coverage on pavement. For a 4-inch line, it is suggested that a grid of 4 x 25 inches be used, and for a 12-inch (or larger) line, a grid of 10 x 10 inches. Count the squares that have no paint, e.g., 3 out of 100 squares equal 3% of the paint gone or 97% coverage.

Follow the steps below to take the readings of the pavement markings:

1. Using either the 10- x 10-inch grid or the 4- x 25-inch grid, place the grid on the line to be evaluated.
2. Count the squares that have no paint.
3. The number of squares without paint will be the percentage of paint gone. In other words, if there are 30 out of 100 squares that have no paint, then 30% of the paint is gone.



Cyrus, Holly M., "Development of Methods for Determining Airport Pavement Marking Effectiveness," DOT/FAA/AR-TN03/22, Federal Aviation Administration, March 2003.

## ITEM

### 537 RAISED PAVEMENT MARKERS

**537.1. DESCRIPTION:** *Provide raised pavement markers which include reflectorized and non-reflecterized traffic buttons, pavement markers and jiggle bars all of which are capable of being attached to a roadway surface by an adhesive.*

**537.2. MATERIALS:** Materials shall conform to the following requirements:

**A. Jiggle Bar Tiles.** TxDOT DMS-4100, “Jiggle Bar Tiles.”

**B. Raised Pavement Markers.** TxDOT DMS-4200, “Pavement Markers (Reflectorized).”

**C. Traffic Buttons.** TxDOT DMS-4300, “Traffic Buttons.”

**D. Testing.** The Engineer reserves the right to perform any or all tests required by this item as a check on the tests reported by the manufacturer. Upon request, the Contractor shall furnish, free of charge, samples of the material of the size and in the amount determined by the Engineer for test purposes. In case of any variance, the Engineer’s tests will govern.

**537.3. EQUIPMENT:** Provide all equipment necessary to perform the work specified herein.

**537.4. CONSTRUCTION:** The Contractor shall establish guides to mark the lateral location of pavement markings as shown on the plans or as directed by the Engineer. The Engineer shall approve locations of these markings and may authorize necessary adjustments from the plans.

The reflective faces of all Type II markers shall be positioned so that the direction of reflection of one (1) face shall be directly opposite to the direction of reflection of the other face.

Raised Pavement markers Type I-C shall have clear reflector face towards traffic. Raised pavement markers Type II C-R, shall have the clear face toward the normal traffic flow and the red face toward wrong-way traffic.

Unless otherwise shown on the plans or specified by the Engineer, all raised pavement markers placed in broken lines shall be placed in line with and midway between the stripes. The first and last raised pavement marker in a no-passing line shall be a reflective marker. Buttons used to simulate a 10 foot skip lane lines shall be spaced at 40 inches.

The pavement markers not placed in accordance with the plans or as directed by the Engineer shall be removed by the Contractor at the Contractor’s expense.

Removal of existing pavement markers or residual adhesive from a missing pavement marker prior to placement of new or replacement marker(s) shall be in conformance with Item 533, “Cleaning or Removal of Pavement Markings or Markers.” The portion of the highway surface to which the raised pavement marker is attached by the adhesive shall be clean and free of dirt, grease, oil, and moisture at the time of installation. Surface preparation for installation of raised pavement markers will not be paid for directly, but shall be considered subsidiary to this item. Unsound pavement or other materials that would adversely affect the bond of the adhesive shall not be an acceptable surface.

The hot epoxy adhesive shall be applied so that 100 percent of the bonding area of the raised pavement marker will be in contact and shall be of sufficient thickness so that excess adhesive shall be forced out around the perimeter of the raised pavement marker but without impairing the functional capability of the reflectivity of the pavement marker. When the project is complete, the raised pavement marker shall be firmly bonded to the pavement; lines formed by the raised pavement markers shall be true, and the entire installation shall present a neat appearance.

Where required by the Engineer, pavement markings outside the limits of this project will be removed or adjusted to provide for a proper tie into this project. The old markings shall be removed or defaced in such a manner that they do not give the appearance of traffic pavement markings.

**537.5. MEASUREMENT:** Measurement will be based on the number of satisfactorily installed pavement markers.

**537.6. PAYMENT:** Pavement markers will be paid for at the contract unit bid price per each type of marker. The price shall be full compensation for furnishing the raised pavement marker, epoxy adhesive and all other materials, surface preparation, installation, labor, equipment, tools and incidentals necessary to complete the work.

**537.7. BID ITEM:**

Item 537.1 - ' N/A

Item 537.2 - Traffic Button (Type Y) per each

N/A

## ITEM

### 540 TEMPORARY EROSION, SEDIMENTATION AND WATER POLLUTION PREVENTION AND CONTROL

- 540.1. DESCRIPTION:** *This item shall govern the control measures necessary to prevent and control soil erosion, sedimentation and water pollution which may degrade receiving waters including rivers, streams, lakes, reservoirs, tidal water, groundwater and wetlands.*

Note: The control measures contained herein shall be installed and maintained throughout the construction contract and coordinated with the permanent or existing temporary pollution control features specified elsewhere on the plans and in the specifications to assure effective and continuous water pollution control throughout the construction and post construction period. These control measures shall not be used as a substitute for the permanent pollution control measures unless otherwise directed by the Engineer in writing. The controls may include sediment control fences, inlet protection, baled hay, rock filter dams, dikes, swales, sediment traps and basins, pipe slope drains, paved flumes, construction exits, temporary seeding, sodding, mulching, soil retention blankets or other structural or non-structural water pollution controls. This item does not apply to commercial operations.

- 540.2. MATERIALS:** The items, estimated quantities and locations of the control measures are shown on the plans; however, the Engineer may increase or decrease the quantity of these items as the need arises. The materials will be shown on the plans and in this specification. The Engineer may allow other materials and work as the need arises and as approved in writing. Pollution control measures may be applicable to contractor operations outside the right of way where such work is necessary as a result of roadway related construction such as construction and haul roads, field offices, equipment and supply areas, and materials sources.

Unless otherwise shown on the plans, provide materials that meet the following requirements:

#### A. Rock Filter Dams.

1. **Aggregate.** Furnish aggregate with hardness, durability, cleanliness, and resistance to crumbling, flaking, and eroding acceptable to the Engineer. Provide the following:
  - **Types 1, 2, and 4 Rock Filter Dams.** Use 3 to 6 in. aggregate.
  - **Type 3 Rock Filter Dams.** Use 4 to 8 in. aggregate.
2. **Wire.** Provide minimum 20 gauge galvanized wire for the steel wire mesh and tie wires for Types 2 and 3 rock filter dams. Type 4 dams require:
  - a double-twisted, hexagonal weave with a nominal mesh opening of 2½ in. x 3¼ in.;
  - minimum 0.0866 in. steel wire for netting;
  - minimum 0.1063 in. steel wire for selvages and corners; and
  - minimum 0.0866 in. for binding or tie wire.
3. **Sandbag Material.** Furnish sandbags meeting Section 540.2.I, "Sandbags," except that any gradation of aggregate may be used to fill the sandbags.

- B. Temporary Pipe Slope Drains.** Provide corrugated metal pipe, polyvinyl chloride (PVC) pipe, flexible tubing, watertight connection bands, grommet materials, prefabricated fittings, and flared entrance sections that conform to the plans. Recycled and other materials meeting these requirements are allowed if approved. Furnish concrete in accordance with Item 505, "Concrete Riprap."
- C. Baled Hay.** Provide hay bales weighing at least 50 lb., composed entirely of vegetable matter, measuring 30 in. or longer, and bound with wire, nylon, or polypropylene string.
- D. Temporary Paved Flumes.** Furnish asphalt concrete, hydraulic cement concrete, or other comparable non-erodible material that conforms to the plans. Provide rock or rubble with a minimum diameter of 6 in. and a maximum volume of ½ cu. ft. for the construction of energy dissipaters.
- E. Construction Exits.** Provide materials that meet the details shown on the plans and this Section.
- 1. Rock Construction Exit.** Provide crushed aggregate for long and short-term construction exits. Furnish aggregates that are clean, hard, durable, and free from adherent coatings such as salt, alkali, dirt, clay, loam, shale, soft, or flaky materials and organic and injurious matter. Use 4- to 8- in. rock for Type 1 and 2- to 4- in. rock for Type 3. Unless otherwise shown on the plans, provide a light weight (4 oz.) non-woven filter fabric below the ballast to prevent mud and sediment migration.
  - 2. Timber Construction Exit.** Furnish No. 2 quality or better railroad ties and timbers for long-term construction exits, free of large and loose knots and treated to control rot. Fasten timbers with nuts and bolts or lag bolts, of at least ½ in. diameter, unless otherwise shown on the plans or allowed. For short-term exits, provide plywood or pressed wafer board at least ½ in. thick.
  - 3. Foundation Course.** Provide a foundation course consisting of flexible base, bituminous concrete, hydraulic cement concrete, or other materials as shown on the plans or directed.
- F. Embankment for Erosion Control.** Provide rock, loam, clay, topsoil, or other earth materials that will form a stable embankment to meet the intended use.
- G. Pipe.** Provide pipe outlet material in accordance with TxDOT Standard Specification Item 556, "Pipe Underdrains," and details shown on the plans.
- H. Construction Perimeter Fence.**
- 1. Posts.** Provide essentially straight wood or steel posts that are at least 60 in. long. Furnish soft wood posts with a minimum diameter of 3 in. or use 2 x 4 boards. Furnish hardwood posts with a minimum cross-section of 1½ x 1-1/5 in. Furnish T- or L-shaped steel posts with a minimum weight of 0.95 lb. per foot.
  - 2. Fence.** Provide orange construction fencing as approved by the Engineer.
  - 3. Fence Wire.** Provide 14 gauge or larger galvanized smooth or twisted wire. Provide 16 gauge or larger tie wire.

4. **Flagging.** Provide brightly-colored flagging that is fade-resistant and at least  $\frac{3}{4}$  in. wide to provide maximum visibility both day and night.
  5. **Staples.** Provide staples with a crown at least  $\frac{1}{2}$  in. wide and legs at least  $\frac{1}{2}$  in. long.
  6. **Used Materials.** Previously used materials meeting the applicable requirements may be used if accepted by the Engineer.
- I. Sandbags.** Provide sandbag material of polypropylene, polyethylene, or polyamide woven fabric with a minimum unit weight of 4 oz. per square yard, a Mullen burst-strength exceeding 300 psi, and an ultraviolet stability exceeding 70%. Use natural coarse sand or manufactured sand meeting the gradation given in Table 1 to fill sandbags. Filled sandbags must be 24 to 30 in. long, 16 to 18 in. wide, and 6 to 8 in. thick.

**Table 1**  
**Sand Gradation**

Sieve #	Maximum Retained (% by Weight)
4	3%
100	80%
200	95%

- J. Temporary Sediment Control Fence.** Provide a net-reinforced fence using woven geotextile fabric. Logos visible to the traveling public will not be allowed.
1. **Fabric.** Provide fabric materials in accordance with TxDOT DMS-6230, "Temporary Sediment Control Fence Fabric."
  2. **Posts.** Provide essentially straight wood or steel posts with a minimum length of 48 in., unless otherwise shown on the plans. Soft wood posts must be at least 3 in. in diameter or nominal 2 x 4 in. Hardwood posts must have a minimum cross-section of  $1\frac{1}{2}$  x  $1\frac{1}{2}$  in. T- or L-shaped steel posts must have a minimum weight of 0.95 lb. per foot.
  3. **Net Reinforcement.** Provide net reinforcement of at least 14 gauge galvanized welded wire mesh, with a maximum opening size of 2 x 4 in., at least 24 in. wide, unless otherwise shown on the plans.
  4. **Staples.** Provide staples with a crown at least  $\frac{3}{4}$  in. wide and legs  $\frac{1}{2}$  in. long.
  5. **Used Materials.** Use recycled material meeting the applicable requirements if accepted by the Engineer.
- K. Curb Inlet Gravel Filters.**
1. **Gravel Filter Bags.** Furnish gravel filter bags meeting Section 540.2.I, "Sandbags." Gravel bags shall be filled with  $\frac{3}{4}$  inch gravel.
  2. **Concrete Masonry Units.** Hollow, Non-Load-Bearing Concrete blocks of 1500-2000 psi, 28-day compressive strength concrete shall be used with dimensions of 8" x 6" x 6" width, height, and length, respectively.
  3. **Wood Blocks.** Wolmanized treated 2" x 4" lumber with the length as per inlet size.

- 540.3. EQUIPMENT.** Provide a backhoe, front end loader, blade, scraper, bulldozer, or other equipment as required when “Earthwork for Erosion Control” is specified on the plans as a bid item.
- 540.4. CONSTRUCTION:** The contractor shall provide control measures to prevent or minimize the impact to receiving waters as required by the plans and/or as directed by the Engineer in writing.

**A. Contractor Responsibilities.**

- 1. SW3P.** Implement the City’s Storm Water Pollution Prevention Plan (SWP3) for the project site in accordance with the specific or general storm water permit requirements. Prevent water pollution from storm water associated with construction activity from entering any surface water or private property on or adjacent to the project site. The Contractor shall effectively prevent and control erosion and sedimentation on the site at the earliest practicable time as outlined in the approved schedule. Control measures, where applicable, will be implemented prior to the commencement of each construction operation or immediately after the area has been disturbed.
- 2. Preconstruction Submittals.**
  - a. Operations on Right of Way.** Prior to the start of construction, the Contractor shall submit to the Engineer, for approval, schedules for accomplishment of the pollution control measures in accordance with the Storm Water Pollution Prevention Plan (SW3P). A plan for the disposal of waste materials generated on the project site must be submitted for approval, also. The Contractor shall submit to the Engineer, for approval, the proposed SW3P for the industrial activities (such as hot mix plants, concrete batch plants, or material handling areas) on the right of way.
  - b. Operations off Right of Way.** The Contractor shall provide the Engineer, for information purposes only, proposed methods of pollution control for Contractor operations in areas which are outside the right of way (such as construction and haul roads, field offices, equipment and supply areas, and material sources).

Pollution control measures for the Contractor's facilities off the right of way are not covered by the City's Environmental Protection Agency (EPA) NPDES general permit. The Contractor shall obtain his own Notice of Intent for the off-site operations. These pollution controls will not be measured for payment but shall be performed at the Contractor's expense.

**B. General.**

- 1. Phasing.** Implement control measures in the area to be disturbed before beginning construction, or as directed. Limit the disturbance to the area shown on the plans or as directed. If, in the opinion of the Engineer, the Contractor cannot control soil erosion and sedimentation resulting from construction operations, the Engineer will limit the disturbed area to that which the Contractor is able to control. Minimize disturbance to vegetation.
- 2. Rainfall Events.** A rain gauge shall be provided by the Contractor and located at the project site. Within 24 hours of a rainfall event of ½ inch or more as measured by the project rain gauge, the Contractor and Inspector will inspect the entire project to

determine the condition of the control measures. Maintain control measures in accordance with Item 540.4.B.3, "Maintenance."

3. **Maintenance.** Correct ineffective control measures in accordance with this section. Implement additional controls as directed. Remove excavated material within the time requirements specified in the applicable storm water permit.

Following a rain event as described in Item 540.4.B.2, "Rainfall Event," sediment will be removed and devices repaired as soon as practicable but no later than 7 days after the surrounding exposed ground has dried sufficiently to prevent further damage from equipment needed for repair of control measures.

In the event of continuous rainfall over a 24-hour period, or other circumstances that preclude equipment operation in the area, the Contractor will hand carry and install additional backup devices as determined by the Engineer. The Contractor will remove silt accumulations and deposit the spoils in an area approved by the Engineer as soon as practical. Any corrective action needed for the control measures will be accomplished in the sequence directed by the Engineer; however, areas adjacent to waterbodies shall generally have priority followed by devices protecting storm sewer inlets.

4. **Stabilization.** Stabilize disturbed areas where construction activities will be temporarily stopped, or construction becomes inactive, in accordance with the applicable storm water permit. Inactive construction areas are defined as areas in which no construction activity will occur for a period of 30 days or longer. Inactive construction areas which have been disturbed will require stabilization through the use of vegetation, mulch, erosion control matting or structural methods within 7 calendar days from the last construction activity in the area. At all times prior to stabilization, inactive construction areas shall be considered as active, disturbed construction area, contributing to the sediment loading at the site control systems. After stabilization, inactive construction areas will be considered undisturbed areas, eliminating the contribution of sediment to the erosion control devices.
5. **Finished Work.** Upon acceptance of vegetative cover, remove and dispose of all temporary control measures, temporary embankments, bridges, matting, falsework, piling, debris, or other obstructions placed during construction that are not a part of the finished work, or as directed. Soil retention blankets shall be removed only when, in the opinion of the Engineer, final permanent perennial seeding would be adversely affected by the presence of an existing soil retention blanket.

The project will not be accepted until a 70% density of existing adjacent undisturbed areas is obtained, unless otherwise shown on the plans. When shown on the plans, the Engineer may accept the project when adequate controls are in place that will control erosion, sedimentation, and water pollution until sufficient vegetative cover can be established.

6. **Restricted Activities.** Do not locate disposal areas, stockpiles, or haul roads in any wetland, water body, or streambed. Do not install temporary construction crossings in or across any water body without the prior approval of the appropriate resource agency and the Engineer. Restrict construction operations in any water body to the necessary areas as shown on the plans or applicable permit, or as directed. Use temporary bridges, timber mats, or other structurally sound and non-eroding material for stream crossings.

Provide protected storage area for paints, chemicals, solvents, and fertilizers at an approved location. Keep paints, chemicals, solvents, and fertilizers off bare ground and provide shelter for stored chemicals.

**C. Installation, Maintenance, and Removal Work.** Perform work in accordance with the specific or general storm water permit. Install and maintain the integrity of temporary erosion and sedimentation control devices to accumulate silt and debris until earthwork construction and permanent erosion control features are in place or the disturbed area has been adequately stabilized as determined by the Engineer. If a device ceases to function as intended, repair or replace the device or portions thereof as necessary. Remove sediment, debris, and litter. When approved, sediments may be disposed of within embankments, or in the right of way in areas where the material will not contribute to further siltation. Dispose of removed material in accordance with federal, state, and local regulations. Remove devices upon approval or when directed. Upon removal, finish-grade and dress the area. Stabilize disturbed areas in accordance with the permit, and as shown on the plans or directed. The Contractor retains ownership of stockpiled material and must remove it from the project when new installations or replacements are no longer required.

**1. Rock Filter Dams for Erosion Control.** Remove trees, brush, stumps, and other objectionable material that may interfere with the construction of rock filter dams. Place sandbags as a foundation when required or at the Contractor's option. For Types 1, 2, 3, and 5, place the aggregate to the lines, height, and slopes specified, without undue voids. For Types 2 and 3, place the aggregate on the mesh and then fold the mesh at the upstream side over the aggregate and secure it to itself on the downstream side with wire ties, or hog rings, or as directed. Place rock filter dams perpendicular to the flow of the stream or channel unless otherwise directed. Construct filter dams according to the following criteria, unless otherwise shown on the plans:

**a. Type 1 (Non-reinforced).**

(1) **Height.** At least 18 in. measured vertically from existing ground to top of filter dam.

(2) **Top Width.** At least 2 ft.

(3) **Slopes.** At most 2:1.

**b. Type 2 (Reinforced).**

(1) **Height.** At least 18 in. measured vertically from existing ground to top of filter dam.

(2) **Top Width.** At least 2 ft.

(3) **Slopes.** At most 2:1.

**c. Type 3 (Reinforced).**

(1) **Height.** At least 36 in. measured vertically from existing ground to top of filter dam.

(2) **Top Width.** At least 2 ft.

- (3) **Slopes.** At most 2:1.
- d. **Type 4 (Sack Gabions).** Unfold sack gabions and smooth out kinks and bends. For vertical filling, connect the sides by lacing in a single loop–double loop pattern on 4- to 5-in. spacing. At one end, pull the end lacing rod until tight, wrap around the end, and twist 4 times. At the filling end, fill with stone, pull the rod tight, cut the wire with approximately 6 in. remaining, and twist wires 4 times. For horizontal filling, place sack flat in a filling trough, fill with stone, and connect sides and secure ends as described above. Lift and place without damaging the gabion. Shape sack gabions to existing contours.
- e. **Type 5.** Provide rock filter dams as shown on the plans.
2. **Temporary Pipe Slope Drains.** Install pipe with a slope as shown on the plans or as directed. Construct embankment for the drainage system in 8-in. lifts to the required elevations. Hand-tamp the soil around and under the entrance section to the top of the embankment as shown on the plans or as directed. Form the top of the embankment or earth dike over the pipe slope drain at least 1 ft. higher than the top of the inlet pipe at all points. Secure the pipe with hold-downs or hold-down grommets spaced a maximum of 10 ft. on center. Construct the energy dissipaters or sediment traps as shown on the plans or as directed. Construct the sediment trap using concrete in accordance with Item 505, “Concrete Riprap,” when designated on the plans. Rubble riprap in accordance with TxDOT Standard Specification Item 432, “Riprap” may also be used when designated on the plans or as directed by the Engineer.
3. **Baled Hay for Erosion and Sedimentation Control.** Install hay bales at locations shown on the plans by embedding in the soil at least 4 in. and, where possible, approximately  $\frac{1}{2}$  the height of the bale, or as directed. Fill gaps between bales with hay.
4. **Temporary Paved Flumes.** Construct paved flumes as shown on the plans or as directed. Provide excavation and embankment (including compaction of the subgrade) of material to the dimensions shown on the plans, unless otherwise indicated. Install a rock or rubble riprap energy dissipater, constructed from the materials specified above to a minimum depth of 9 in. at the flume outlet to the limits shown on the plans or as directed.
5. **Construction Exits.** When tracking conditions exist, prevent traffic from crossing or exiting the construction site or moving directly onto a public roadway, alley, sidewalk, parking area, or other right of way areas other than at the location of construction exits. Construct exits for either long or short-term use.
- a. **Long-Term.** Place the exit over a foundation course, if necessary. Grade the foundation course or compacted subgrade to direct runoff from the construction exits to a sediment trap as shown on the plans or as directed. Construct exits with a width of at least 14 ft. for one-way and 20 ft. for two-way traffic for the full width of the exit, or as directed.
- (1) **Type 1.** Construct to a depth of at least 8 in. using crushed aggregate as shown on the plans or as directed.
- (2) **Type 2.** Construct using railroad ties and timbers as shown on the plans or as directed.

- b. Short-Term.**
  - (1) **Type 3.** Construct using crushed aggregate, plywood, or wafer board. This type of exit may be used for daily operations where long-term exits are not practical.
  - (2) **Type 4.** Construct as shown on the plans or as directed.
- 6. Earthwork for Erosion and Sediment Control.** Perform excavation and embankment operations to minimize erosion and to remove collected sediments from other erosion control devices.
  - a. Excavation and Embankment for Erosion Control Features.** Place earth dikes, swales or combinations of both along the low crown of daily lift placement, or as directed, to prevent runoff spillover. Place swales and dikes at other locations as shown on the plans or as directed to prevent runoff spillover or to divert runoff. Construct cuts with the low end blocked with undisturbed earth to prevent erosion of hillsides. Construct sediment traps at drainage structures in conjunction with other erosion control measures as shown on the plans or as directed. Where required, create a sediment basin providing 3,600 cu. ft. of storage per acre drained, or equivalent control measures for drainage locations that serve an area with 10 or more disturbed acres at one time, not including offsite areas.
  - b. Excavation of Sediment and Debris.** Remove sediment and debris when accumulation affects the performance of the devices, after a rain, and when directed.
- 7. Construction Perimeter Fence.** Construct, align, and locate fencing as shown on the plans or as directed.
  - a. Installation of Posts.** Embed posts 18 in. deep or adequately anchor in rock, with a spacing of 8 to 10 ft.
  - b. Wire Attachment.** Attach the top wire to the posts at least 3 ft. from the ground. Attach the lower wire midway between the ground and the top wire.
  - c. Flag Attachment.** Attach flagging to both wire strands midway between each post. Use flagging at least 18 in. long. Tie flagging to the wire using a square knot.
- 8. Sandbags for Erosion Control.** Construct a berm or dam of sandbags that will intercept sediment-laden storm water runoff from disturbed areas, create a retention pond, detain sediment, and release water in sheet flow. Fill each bag with sand so that at least the top 6 in. of the bag is unfilled to allow for proper tying of the open end. Place the sandbags with their tied ends in the same direction. Offset subsequent rows of sandbags  $\frac{1}{2}$  the length of the preceding row. Place a single layer of sandbags downstream as a secondary debris trap. Place additional sandbags as necessary or as directed for supplementary support to berms or dams of sandbags or earth.
- 9. Temporary Sediment-Control Fence.** Provide temporary sediment-control fence near the downstream perimeter of a disturbed area to intercept sediment from sheet flow. Incorporate the fence into erosion-control measures used to control sediment in areas of higher flow. Install the fence as shown on the plans, as specified in this Section, or as directed.

- a. **Installation of Posts.** Embed posts at least 18 in. deep, or adequately anchor, if in rock, with a spacing of 6 to 8 ft. and install on a slight angle toward the run-off source.
- b. **Fabric Anchoring.** Dig trenches along the uphill side of the fence to anchor 6 to 8 in. of fabric. Provide a minimum trench cross-section of 6 x 6 in. Place the fabric against the side of the trench and align approximately 2 in of fabric along the bottom in the upstream direction. Backfill the trench, then hand-tamp.
- c. **Fabric and Net Reinforcement Attachment.** Unless otherwise shown under the plans, attach the reinforcement to wooden posts with staples, or to steel posts with T-clips, in at least 4 places equally spaced. Sewn vertical pockets may be used to attach reinforcement to end posts. Fasten the fabric to the top strand of reinforcement by hog rings or cord every 15 in. or less.
- d. **Fabric and Net Splices.** Locate splices at a fence post with a minimum lap of 6 in. attached in at least 6 places equally spaced, unless otherwise shown under the plans. Do not locate splices in concentrated flow areas. Requirements for installation of used temporary sediment control fence include the following:
  - fabric with minimal or no visible signs of biodegradation (weak fibers),
  - fabric without excessive patching (more than 1 patch every 15 to 20 ft.),
  - posts without bends, and
  - backing without holes.

#### 10. Curb Inlet Gravel Filter.

- a. **Installation.** Install the curb inlet gravel filters in the following manner:
  - (1) Place the 2" x 4" treated lumber in front of and parallel with the opening of the inlet.
  - (2) Place the Concrete Masonry Units (CMUs) around the inlet, to be protected, in front of the 2" x 4" lumber, with the openings of the CMUs facing the inlet.
  - (3) Surround the CMUs with gravel bags, making certain that there are no gaps are evident between the gravel bags.
- b. **Sediment Control.** When the accumulated sediment deposit reaches a depth of approximately 6 inches, it shall be removed and disposed of at approved sites in a manner that will not contribute to additional siltation. If the structure ceases to function as intended, the Engineer may direct that the Filter bag be replaced. Such replacement will not be measured for payment. Torn or punctured bags shall be replaced with a new Filter bag.

**540.5. MEASUREMENT:** If the Contractor is required to install temporary erosion, sediment and water pollution control measures due to his negligence, carelessness, lack of maintenance, or failure to install permanent controls as a part of the work as scheduled, and measures are ordered in writing by the Engineer, such work shall not be measured for payment, but shall be performed at the Contractor's expense.

In case of failure on the part of the Contractor to prevent and control soil erosion, sedimentation and water pollution which may degrade receiving water, the Engineer reserves the right to employ outside assistance or to use City forces to provide the necessary corrective measures. All costs including engineering costs will be deducted from any moneys due or to become due to the Contractor.

When the need for control measures can not be attributed to the contractor's negligence, carelessness, lack of maintenance or failure to install permanent water pollution control measures and these measures are shown on the plans and/or directed by the Engineer, these measures shall be measured and paid for in accordance with contract bid items shown under this section.

- A. Rock Filter Dams.** Installation or removal of rock filter dams will be measured by the foot or by the cubic yard. The measured volume will include sandbags, when used.
  - 1. Linear Measurement.** When rock filter dams are measured by the foot, measurement will be along the centerline of the top of the dam.
  - 2. Volume Measurement.** When rock filter dams are measured by the cubic yard, measurement will be based on the volume of rock computed by the method of average end areas.
    - a. Installation.** Measurement will be made in final position.
    - b. Removal.** Measurement will be made at the point of removal.
- B. Temporary Pipe Slope Drains.** Temporary pipe slope drains will be measured by the foot.
- C. Baled Hay.** Baled hay will be measured by each bale.
- D. Temporary Paved Flumes.** Temporary paved flumes will be measured by the square yard of surface area. The measured area will include the energy dissipater at the flume outlet.
- E. Construction Exits.** Construction exits will be measured by the square yard of surface area.
- F. Earthwork for Erosion and Sediment Control.** Earthwork for erosion and sediment control will not be measured directly but will be considered subsidiary to this or other pertinent items.
- G. Construction Perimeter Fence.** Construction perimeter fence will be measured by the foot.
- H. Sandbags for Erosion Control.** Sandbags will be measured as each sandbag or by the foot along the top of sandbag berms or dams.
- I. Temporary Sediment-Control Fence.** Temporary sediment-control fence will be measured by the foot.
- J. Curb Inlet Gravel Filter.** Curb inlet gravel filter will be measured by the linear foot, as measured on the centerline of the gravel bags installed.

**540.6. PAYMENT:** The following will not be paid for directly but are subsidiary to pertinent Items:

- erosion-control measures for Contractor project-specific locations (PSLs) inside and outside the right of way (such as construction and haul roads, field offices, equipment and supply areas, plants, and material sources);
- removal of litter;
- repair to devices and features damaged by Contractor operations;
- added measures and maintenance needed due to negligence, carelessness, lack of maintenance, and failure to install permanent controls;
- removal and reinstallation of devices and features needed for the convenience of the Contractor;
- finish grading and dressing upon removal of the device; and
- minor adjustments including but not limited to plumbing posts, reattaching fabric, minor grading to maintain slopes on an erosion embankment feature, or moving small numbers of sandbags.

The Contractor will be reimbursed for maintenance, repair, or reinstallation of devices and features when the need for additional control measures cannot be attributed to the above, as determined by the Engineer. Stabilization of disturbed areas will be paid for under pertinent Items. Furnishing and installing pipe for outfalls associated with sediment traps and ponds will not be paid for directly but is subsidiary to the excavation and embankment under this Item.

Pollution control measures outside the right of way will not be measured for payment but shall be performed at the Contractor's expense.

Control measures as shown on the plans will be paid for in accordance with applicable bid items as shown below:

**A. Rock Filter Dams.** The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid as follows:

- 1. Installation.** Installation will be paid for as "Rock Filter Dams (Install)" of the type specified. This price is full compensation for furnishing and operating equipment, finish backfill and grading, lacing, proper disposal, labor, materials, tools, and incidentals.
- 2. Removal.** Removal will be paid for as "Rock Filter Dams (Remove)." This price is full compensation for furnishing and operating equipment, proper disposal, labor, materials, tools, and incidentals.

When the Engineer directs that the rock filter dam installation or portions thereof be replaced, payment will be made at the unit price bid for "Rock Filter Dams (Remove)" and for "Rock Filter Dams (Install)" of the type specified. This price is full compensation for furnishing and operating equipment, finish backfill and grading, lacing, proper disposal, labor, materials, tools, and incidentals

**B. Temporary Pipe Slope Drains.** The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Temporary Pipe Slope Drains" of the size specified. This price is full

compensation for furnishing materials, removal and disposal, furnishing and operating equipment, labor, tools, and incidentals.

Removal of temporary pipe slope drains will not be paid for directly but is subsidiary to the installation Item. When the Engineer directs that the pipe slope drain installation or portions thereof be replaced, payment will be made at the unit price bid for "Temporary Pipe Slope Drains" of the size specified, which is full compensation for the removal and reinstallation of the pipe drain.

Earthwork required for the pipe slope drain installation, including construction of the sediment trap, will be measured and paid for under Section 540.5.F, "Earthwork for Erosion and Sediment Control." Riprap concrete or stone, when used as an energy dissipater or as a stabilized sediment trap, will be measured and paid for in accordance with Item 505, "Concrete Riprap" or TxDOT Item 432, "Riprap," respectively.

- C. Baled Hay.** The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Baled Hay." This price is full compensation for furnishing and placing bales, excavating trenches, removal and disposal, equipment, labor, tools, and incidentals.

When the Engineer directs that the baled hay installation (or portions thereof) be replaced, payment will be made at the unit price bid for "Baled Hay," which is full compensation for removal and reinstallation of the baled hay.

- D. Temporary Paved Flumes.** The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Temporary Paved Flume (Install)" or "Temporary Paved Flume (Remove)." This price is full compensation for furnishing and placing materials, removal and disposal, equipment, labor, tools, and incidentals.

When the Engineer directs that the paved flume installation or portions thereof be replaced, payment will be made at the unit prices bid for "Temporary Paved Flume (Remove)" and "Temporary Paved Flume (Install)." These prices are full compensation for the removal and replacement of the paved flume and for equipment, labor, tools, and incidentals.

Earthwork required for the paved flume installation, including construction of a sediment trap will be considered subsidiary to this item and will not be measured or paid for directly.

- E. Construction Exits.** Contractor-required construction exits from off right-of-way locations or on-right of way PSLs will not be paid for directly but are subsidiary to pertinent Items.

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" for construction exits needed on right-of-way access to work areas required by the Department will be paid for at the unit price bid for "Construction Exits (Install)" of the type specified or "Construction Exits (Remove)." This price is full compensation for furnishing and placing materials, excavating, removal and disposal, cleaning vehicles, labor, tools, and incidentals.

When the Engineer directs that a construction exit or portion thereof be removed and replaced, payment will be made at the unit prices bid for "Construction Exit (Remove)" and "Construction Exit (Install)" of the type specified. These prices are full compensation for the

removal and replacement of the construction exit and for equipment, labor, tools, and incidentals.

Construction of sediment traps used in conjunction with the construction exit will be considered subsidiary to this item and will not be measured or paid for directly.

- F. Earthwork for Erosion and Sediment Control.** The work performed and materials furnished in accordance with this Item will not be paid for directly but is subsidiary to pertinent Items unless otherwise shown on the plans.

Sprinkling and rolling required by this Item will not be paid for directly, but will be subsidiary to this Item.

- G. Construction Perimeter Fence.** The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Construction Perimeter Fence." This price is full compensation for furnishing and placing the fence; digging, fence posts, wire, and flagging; removal and disposal; and materials, equipment, labor, tools, and incidentals.

Removal of construction perimeter fence will be not be paid for directly but is subsidiary to the installation Item. When the Engineer directs that the perimeter fence installation or portions thereof be removed and replaced, payment will be made at the unit price bid for "Construction Perimeter Fence," which is full compensation for the removal and reinstallation of the construction perimeter fence.

- H. Sandbags for Erosion Control.** Sandbags will be paid for at the unit price bid for "Sandbags for Erosion Control" (of the height specified when measurement is by the foot). This price is full compensation for materials, placing sandbags, removal and disposal, equipment, labor, tools, and incidentals.

Removal of sandbags will not be paid for directly but is subsidiary to the installation Item. When the Engineer directs that the sandbag installation or portions thereof be replaced, payment will be made at the unit price bid for "Sandbags for Erosion Control," which is full compensation for the reinstallation of the sandbags.

- I. Temporary Sediment-Control Fence.** The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Temporary Sediment-Control Fence." This price is full compensation for furnishing and placing the fence; trenching, fence posts, fabric and backfill; removal and disposal; and equipment, labor, tools, and incidentals.

Removal of temporary sediment-control fence will not be paid for directly but is subsidiary to the installation Item. When the Engineer directs that the temporary sedimentation control fence installation or portions thereof be replaced, payment will be made at the unit price bid for "Temporary Sediment-Control Fence," which is full compensation for the removal and reinstallation of the temporary sediment-control fence.

- J. Curb Inlet Gravel Filter.** The work performed and the materials furnished as specified herein, measured as provided under "Measurement" will be paid for at the unit price bid per linear foot for "Curb Inlet Gravel Filter," which payment shall be full compensation for furnishing all materials, labor, tools, equipment and incidentals necessary to complete the work as specified, including maintaining and replacing the gravel bags as required by these

specifications, removal of accumulated silt, and removal and proper disposal of the “Curb Inlet Gravel Filter” upon completion of site stabilization.

**540.7. BID ITEM:**

Item 540.1 - Temporary Erosion, Sedimentation, and Water Pollution Prevention and Control - Lump Sum

## ITEM

### 618 CONDUIT

**618.1. DESCRIPTION:** *Furnish and place conduit.*

**618.2. MATERIALS:** Provide new materials that comply with the details shown on the plans, the requirements of this Item, and the pertinent requirements of Item 622, "Duct Cable."

When specified on the plans, provide:

- rigid metal (RM) conduit that is hot-dip galvanized inside and outside with a minimum of 1.5 oz. per square foot of a zinc coating in accordance with Texas Department of Transportation (TxDOT) Standard Specification Item 445, "Galvanizing;"
- electrical metallic tubing (EMT) and intermediate metal conduit (IMC) that is steel, galvanized on the outside, and protected on the inside with a suitable corrosion-resistant material;
- polyvinyl chloride (PVC) conduit that meets the requirements of NEMA Standard TC-2, UL 651, and the NEC;
- high-density polyethylene (HDPE) conduit without factory-installed conductors that meets the requirements of Item 622, "Duct Cable"; or
- flexible conduit that is liquid-tight.

Furnish conduit from new materials that comply with TxDOT DMS-11030, "Conduit."

Provide conduit from manufacturers prequalified by the Texas Department of Transportation. The TxDOT Traffic Operations Division maintains a list of prequalified electrical conduit manufacturers.

Unless otherwise shown on the plans, fabricate fittings such as junction boxes and expansion joints from a material similar to the connecting conduit. Use watertight fittings. Do not use set screw and pressure-cast fittings. Steel compression fittings are permissible. When using HDPE conduit, provide fittings that are UL-listed as electrical conduit connectors or thermally fused using an electrically heated wound wire resistance welding method.

Use red 3-in. 4-mil polyethylene underground warning tape that continuously states "Caution Buried Electrical Line Below."

**618.3. EQUIPMENT:** Provide the machinery, tools and equipment necessary for proper prosecution of the work. All machinery, tools and equipment used shall be maintained in a satisfactory and workmanlike manner.

**618.4. CONSTRUCTION:** Place conduit in accordance with the lines, grades, details, and dimensions shown on the plans or as directed. Install conduit a minimum of 18 in. deep underground unless otherwise shown on the plans.

Meet the requirements of the NEC when installing conduit. Secure and support conduit placed for concrete encasement in such a manner that the alignment will not be disturbed during placement of the concrete. Cap ends of conduit and close box openings before concrete is placed.

Ream conduit to remove burrs and sharp edges. Use a standard conduit cutting die with a 3/4-in. taper per foot when conduit is threaded in the field. Fasten conduit placed on structures with conduit straps or hangers as shown on the plans or as directed. Fasten conduit within 3 ft. of each box or fitting and at other locations shown on the plans or as directed. Use metal conduit clamps that are galvanized malleable or stainless steel unless otherwise shown on the plans. Use 2-hole type clamps for 2-in. diameter or larger conduit.

Fit PVC and HDPE conduit terminations with bushings or bell ends. Fit metal conduit terminations with a grounding type bushing, except conduit used for duct cable casing that does not terminate in a ground box and is not exposed at any point. Conduit terminating in threaded bossed fittings does not need a bushing. Prior to installation of conductors or final acceptance, pull a spherical template having a diameter of at least 75% of the inside diameter of the conduit through the conduit to ensure that the conduit is free from obstruction. Cap or plug empty conduit placed for future use.

Perform trench excavation and backfilling as shown on the plans or as directed and in accordance with Item 400, "Excavation, Trenching and Backfilling." Excavation and backfilling will be subsidiary to the installation of the conduit.

Jack and bore as shown on the plans or as directed, and in accordance with Item 406, "Jacking, Boring, or Tunneling."

Place warning tape approximately 10 in. above trenched conduit. Where existing surfacing is removed for placing conduit, repair by backfilling with material equal in composition and density to the surrounding areas and by replacing any removed surfacing, such as asphalt pavement or concrete riprap, with like material to equivalent condition. Mark conduit locations as directed.

**618.5. MEASUREMENT:** Conduit will be measured by the foot of conduit.

This is a plans quantity measurement Item. The quantity to be paid is the quantity shown in the proposal, unless modified by Change Order. Additional measurements or calculations will be made if adjustments of quantities are required.

Boring through soil or rock will be measured in accordance with Item 406, "Jacking, Boring, or Tunneling."

**618.6. PAYMENT:** The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Conduit" of the type and size specified and the installation method specified as applicable. This price is full compensation for furnishing and installing conduit; hanging, strapping, jacking, boring, tunneling, excavating, and furnishing and placing backfill; replacing pavement structure, sod, riprap, curbs, or other surface; marking location of conduit (when required); furnishing and installing fittings, junction boxes, and expansion joints; and equipment, labor, tools and incidentals.

Flexible conduit will not be paid for directly but will be subsidiary to pertinent Items. Unless otherwise shown on the plans, no payment will be allowed under this Item for conduit used on electrical services or in foundations.

**618.7. BID ITEM:**

Item 618.1 - Conduit (1/2 inch/PVC Schedule 40) - per foot

Item 618.2 - Conduit (3/4 inch/PVC Schedule 40) - per foot

Item 618.3 - Conduit (1 inch/PVC Schedule 40) - per foot

Item 618.4 - Conduit (1-1/2 inch/PVC Schedule 40) - per foot

Item 618.5 - Conduit (2 inch/PVC Schedule 40) - per foot

**ITEM****624 GROUND BOXES**

- 624.1. DESCRIPTION:** *Construct, furnish, and install ground boxes complete with lids.*
- 624.2. MATERIALS:** Provide new materials that comply with the details shown on the plans and meet the following requirements:
- A. Cast-In-Place Concrete Ground Boxes.** Construct cast-in-place concrete ground boxes and aprons in accordance with Item 300, "Concrete," and Item 301, "Reinforcing Steel."
  - B. Precast Polymer Concrete Ground Boxes.** Provide fabricated precast polymer concrete ground boxes, and precast concrete ground boxes that comply with Texas Department of Transportation DMS-11070, "Ground Boxes."
  - C. Concrete Apron.** Construct a concrete apron, when shown on the plans, in accordance with Item 300, "Concrete," and Item 301, "Reinforcing Steel."
  - D. Suppliers.** Provide ground boxes from manufacturers prequalified by the Texas Department of Transportation (TxDOT). The TxDOT Traffic Operations Division maintains a list of prequalified ground box manufacturers.
- 624.3. EQUIPMENT:** Provide the machinery, tools and equipment necessary for proper prosecution of the work. All machinery, tools and equipment used shall be maintained in a satisfactory and workmanlike manner.
- 624.4. CONSTRUCTION:** Construct and/or place ground boxes in accordance with the appropriate requirements of the Items shown in Section 624.2 "Materials."
- 624.5. MEASUREMENT:** This Item will be measured by each ground box complete in place.
- 624.6. PAYMENT:** The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Ground Boxes" of the types and sizes specified. This price is full compensation for excavating and backfilling; constructing, furnishing, and installing the ground boxes and concrete aprons when required; and equipment, labor, materials, tools, and incidentals.
- 624.7. BID ITEM:**
- Item 624.1 - Ground Boxes Type A (122311) - per each

N/A

## PROJECT SCHEDULING & DATA MANAGEMENT

### ITEM

#### 700 COST LOADED PROJECT SCHEDULES

- 700.1. DESCRIPTION:** *This item shall govern the creation, maintenance, and delivery of Critical Path Method (CPM) project schedules.*
- 700.2. CRITICAL PATH METHOD PROJECT SCHEDULE:** The Contractor shall create and maintain a Critical Path Method (CPM) Project Schedule showing the manner of execution of work that he intends to follow in order to complete the contract within the allotted time. The project schedule shall employ computerized CPM for the planning, scheduling and reporting of the work as described in this specification. The CPM project schedule shall be prepared using the Precedence Diagram Method (PDM) and shall be resource and cost loaded. The Contractor shall create and maintain the schedule using Primavera Project Manager 5.x or Primavera Contractor 4.1 or above. The observance of the requirements herein is an essential part of the work to be done under the contract. No direct compensation will be allowed for fulfilling these requirements, as such work is considered subsidiary to the various bid items of the contract.
- 700.3. PERSONNEL:** The Contractor shall provide an individual, referred to hereafter as the Scheduler, to create and maintain the Project Schedule. The Scheduler shall be proficient in Critical Path Method (CPM) analysis as demonstrated through certification from Project Management Institute (PMI), Association for the Advancement of Cost Engineering (AACE) or possess sufficient experience to be able to perform required tasks on the specified software and be able to prepare and interpret reports from the software. The Scheduler shall be made available for discussion or meetings when requested by the City.
- 700.4. PROJECT SCHEDULE:**
- A. General.** At least twenty (20) calendar days prior to the preconstruction conference, the Contractor shall submit a Project Schedule, which shall show the sequence and interdependence of activities required for complete performance of the work. All schedule submittals shall be in the electronic form to include PDF plots of the schedule, a PDF plot defining the Critical Path and two week look-ahead, and include the native Primavera file format. The Contractor shall submit the schedule to the Web-portal and via electronic mail, CD-Rom, floppy disc, or any other electronic media acceptable to the City. The City will review the Project Schedule within twenty (20) calendar days for compliance with the specifications and notify the Contractor at the pre-construction conference of its acceptability. No work shall begin until the City has accepted the Project Schedule.
- B. Sequence.** The Project Schedule shall show the sequence and interdependence of activities required for complete performance of the work. The Contractor shall be responsible for assuring all work sequences are logical and show a coordinated plan of the work. The purpose of the City requiring the Project Schedule shall be to:
1. Ensure adequate planning during the execution and progress of the work in accordance with the allowable number of calendar days and all milestones,

2. Assure coordination of the efforts of the Contractor, City, Utilities and others that may be involved in the project and that activities are included in the schedule highlighting coordination points with others,
  3. Assist the Contractor and City in monitoring the progress of the work and evaluating proposed changes to the contract, and
  4. Assist the City in administering the contract time requirements.
- C. Activities.** Each activity on the Project Schedule shall include:
1. An activity number utilizing an alphanumeric designation system that is agreeable to the City;
  2. Concise description of the work represented by the activity; and
  3. Activity durations in whole work days with a maximum of twenty (20) work days. Durations greater than twenty (20) work days may be used for non-construction activities (mobilization, submittal preparation, curing, etc.), and other activities mutually agreeable between the City and Contractor.

The Contractor shall provide to the City a legend for all abbreviations. The activities shall be coded so that organized plots of the Project Schedule may be produced. Typical activity coding includes traffic control phase, location and work type. Activity durations shall be based on the quantity for the individual work activity divided by a production rate.

- D. Work Duration and Resources.** The schedule layout shall be grouped by Project and then by WBS for organizational purposes. The original and remaining duration shall be displayed. The grouping band will, by default, report work days planned. One additional level of effort activity shall be added to the schedule as a “time calculator” with a seven-day calendar without holidays. The calculation of their days will show up in the duration columns in Primavera.

If specified by general note, the Contractor shall plan and incorporate major resources into the Project Schedule. Major resources are defined as crews and equipment that constrain the Contractor from pursuing available work. The resources shall accurately represent the Contractor's planned equipment and manpower to achieve the productivity rates specified above.

Work shall be scheduled based upon the Contractor's standard work week utilizing the appropriate calendar assignments in Primavera software for the purpose of establishing an accurate baseline S-curve that accurately represents the Contractor planned rate of earned value. If the Contractor initial baseline plan is to perform the Work on a six or seven-day work week, then the appropriate calendar in Primavera must be used and the Engineer must be notified in writing through the Submittal process. This does not affect the total calendar days allotted by the contract.

Assign working calendars for the days you plan to work. Designate all City holidays (12) as non-working days (holidays). For dates beyond the current calendar year assume that the City holidays are the same as the current calendar year.

Seasonal weather conditions shall be considered and included in the Project Schedule for all work influenced by temperature and/or precipitation. Seasonal weather conditions shall be determined by an assessment of average historical climatic conditions. Average historical weather data is available through the National Oceanic and Atmospheric Administration (NOAA). These effects will be simulated through the use of work calendars for each major work type (i.e., earthwork, concrete paving, structures, asphalt, drainage, etc.). Project and work calendars should be updated each month to show days actually able to work on the various work activities.

Total float is defined as the amount of time between the early start date and the late start date, or the early finish date and the late finish date, for each and every activity in the schedule. Float time in the Project Schedule is a shared commodity between the City and the Contractor.

Only City responsible delays in activities that affect milestone dates or the contract completion date, as determined by CPM analysis, will be considered for a time extension.

- E. Resources and Cost Loading Requirement.** Assign resources to each activity to include budgeted units and budgeted cost calculated as budgeted units x unit price.

Percent complete type shall be Physical Percent Complete.

Duration type shall be Fixed Units

Earned value shall be reported from the schedule.

- F. Other Requirements.** Code and organize all work by WBS.

Submittals shall be included in the schedule with a logical tie to what each drives.

Proposed Change Orders shall be added the schedule identifying it as a Proposed Change Order. This task must be linked to the schedule with logical ties and approved by the City. Upon approval of Change Order, task will be renamed identifying work performed and Change Order number and resources will be added to the task.

Constraints are limited to project start, project finish, material delivery, and use on Submittals. If a schedule requires additional constraints, then an explanation shall accompany the schedule Submittal.

The schedule shall include activity milestones for material delivery.

Must Finish By date shall be identified in the schedule based on the Contract time.

Default progress is disallowed. Quantities installed shall be the basis of earned value.

If work is performed out of sequence, then an explanation must be included in the project narrative.

- 700.5. JOINT REVIEW, REVISION AND ACCEPTANCE:** Within twenty (20) calendar days of receipt of the Contractor's proposed Project Schedule, the City shall evaluate the schedule for compliance with this specification, and notify the Contractor of its findings. If the City requests a revision or justification, the Contractor shall provide a satisfactory revision or adequate justification to the satisfaction of the City within seven (7) calendar days. If the Contractor

submits a Project Schedule for acceptance, which is based on a sequence of work not shown in the plans, then the Contractor shall notify the City in writing, separate from the schedule submittal.

The City's review and acceptance of the Contractor's Project Schedule is for conformance to the requirements of the contract documents only. Review and acceptance by the City of the Contractor's Project Schedule does not relieve the Contractor of any of its responsibility for the Project Schedule or of the Contractor's ability to meet interim milestone dates (if specified) and the contract completion date, nor does such review and acceptance expressly or by implication warrant, acknowledge or admit the reasonableness of the logic, durations, manpower or equipment loading of the Contractor's Project Schedule. In the event the Contractor fails to define any element of work, activity or logic and the City review does not detect this omission or error, such omission or error, when discovered by the Contractor or City shall be corrected by the Contractor at the next monthly schedule update and shall not affect the project completion date.

**700.6. UPDATES:** The Project Schedule shall be updated on a monthly basis. The Project Schedule update shall be submitted in conjunction with the pay application. The Contractor will meet with the City each month at a scheduled update meeting to review actual progress made through the Data Date of the schedule update as determined the Project Manager. The review of progress will include dates activities actually started and/or completed, the percentage of work completed, the remaining duration of each activity started and/or completed, and the amount of work to complete with an analysis of the relationship between the remaining duration of the activity and the quantity of material to install over that given period of time with a citation of past productivity. The percentage of work complete shall be calculated by utilizing the quantity installed divided by the budgeted quantity from the baseline schedule. The monthly schedule update shall include a progress narrative explaining progress, defining the Critical Path, identification of any potential delays, etc.

The project schedule update layout shall be grouped by Project, then WBS. The layout shall include the following columns:

- A. Activity ID
- B. Activity Description
- C. Original Durations
- D. Remaining Durations
- E. Start and Finish Dates
- F. Baseline Start and Finish Dates
- G. Total Float
- H. Performance Percent Complete
- I. Budgeted Total Cost
- J. Earned Value
- K. Display logic and target bars in the Gantt bar chart view

**700.7. PROJECT SCHEDULE REVISIONS:** If the Contractor desires to make major changes in the Project Schedule, the Contractor shall notify the City in writing and submit the proposed schedule revision. The written notification shall include the reason for the proposed revision, what the revision is comprised of, and how the revision was incorporated into the schedule. Major changes are hereby defined as those that may affect compliance with the contract requirements or those that change the critical path. All other changes may be accomplished through the monthly updating process without written notification.

**700.8. TIME IMPACT ANALYSIS:** The Contractor shall notify the City when an impact may justify an extension of contract time or adjustment of milestone dates. This notice shall be made in writing as soon as possible, but no later than the end of the next estimate period after the commencement of an impact or the notice for a change is given to the Contractor. Not providing notice to the City within twenty (20) calendar days after receipt will indicate the Contractor's approval of the time charges as shown on that time statement. Future consideration of that statement will not be permitted and the Contractor forfeits his right to subsequently request a time extension or time suspension unless the circumstances are such that the Contractor could not reasonably have knowledge of the impact by the end of the next estimate period.

When changes are initiated or impacts are experienced, the Contractor shall submit to the City a written time impact analysis describing the influence of each change or impact. A "time impact analysis" is an evaluation of the effects of changes in the construction sequence, contract, plans, or site conditions on the Contractor's plan for constructing the project, as represented by the schedule. The purpose of the time impact analysis is to determine if the overall project has been delayed, and if necessary, to provide the Contractor and the City a basis for making adjustments to the contract.

A time impact analysis shall consist of one or all of the steps listed below:

- A. Establish the status of the project before the impact using the most recent project schedule update prior to the impact occurrence.
- B. Predict the effect of the impact on the most recent project schedule update prior to the impact occurrence. This requires estimating the duration of the impact and inserting the impact into the schedule update. Any other changes made to the schedule including modifications to the calendars or constraints shall be noted.
- C. Track the effects of the impact on the schedule during its occurrence. Note any changes in sequencing, and mitigation efforts.
- D. Compare the status of the work prior to the impact (Step 1) to the prediction of the effect of the impact (Step 2), and to the status of the work during and after the effects of the impact are over (Step 3). Note that if an impact causes a lack of access to a portion of the project, the effects of the impact may extend to include a reasonable period for remobilization.

The time impact analysis shall be electronically submitted to the City. If the Project Schedule is revised after the submittal of a time impact analysis but prior to its approval, the Contractor shall promptly indicate in writing to the City the need for any modification to its time impact analysis. One (1) copy of each time impact analysis shall be submitted within fourteen (14) calendar days after the completion of an impact. The City may require Step 1 and Step 2 of the time impact analysis be submitted at the commencement of the impact, if needed to make a decision regarding the suspension of contract time. Approval or rejection of each time impact analysis by the City

shall be made within fourteen (14) calendar days after receipt unless subsequent meetings and negotiations are necessary.

**700.9. MEASUREMENT and PAYMENT:** Cost Loaded Project Schedules will not be measured or paid for directly, but shall be included in the unit price bid for the items of construction in which the operations occur.

**700.10. BID ITEM:**

N/A