Subsection 4.01
Utility Construction in City of Amarillo Right-of-Way and Easements

I. Scope: This subsection contains the required methods and materials for utility construction in streets, alleys, easements, and other public right-of-ways. This item applies to excavations, trenches, and surface restorations for utility extensions, connections, conduit placement, utility repair, and other utility construction within City Right of Way.

In the remaining portions of this subsection, Contractor is used to describe the independent Contractor, the City Department, or utility company franchised by the City of Amarillo that is performing the particular utility construction.

II. Material

A. Backfill For Unimproved Alleys:

1. Use excavated material from the utility installation without any debris, such as used concrete, hot mix, lumber of other foreign material.

B. Backfill for Paved Alleys and Streets

1. Sand that meets the gradation for fine aggregate in Subsection 4.08 "Concrete".

2. Aggregate shown in Subsection 5.01.IV.F "Backfill."

3. Controlled Low Strength Material (Flowable Fill).

a) Aggregate shall meet the requirements of Table 1. Gradation shall be determined in accordance with Tex-401-A. Plasticity Index (PI) shall not exceed 6 when tested in accordance with Tex-106-E.

Table 1
Aggregate Gradation

Sieve Size	Percent Passing
¾ inch	100
#200	0-30

Furnish flowable fill meeting the requirements of Table 2.

Table 2
Flowable Fill Mix Design Requirements.

Property	Requirement	Test Method
28 day compressive strength[1], psi	50-150	ASTM D 4832
Consistency[2], min diameter, inches	8	ASTM D 6103
Unit weight, pcf	90-125	ASTM D 6023
Air Content, %	10-30	ASTM D 6023

[1] Average of 2 Specimens.
[2] Mixture must not segregate.

Mix the flowable fill using a central mixed plant and deliver using a ready mix concrete truck, unless otherwise approved.

4. Water: Water usage shall conform to Subsection 3.04 "Requirements for Water Usage."

C. Trench Cap

1. Portland Cement Concrete: Concrete shall conform to Subsection 4.08, "Concrete." Concrete shall be 3000 psi concrete.

2. Flexible Base: Flexible base shall conform to Subsection 4.07 "Flexible Base". Base shall be Grade II and any type shown in the subsection.

D. Surface

1. Asphaltic Concrete (Hot-Mix): Asphaltic Concrete shall conform to Subsection 4.17 "Dense-Graded Hot-Mix Asphalt." Hot mix shall be Ty D unless otherwise approved.

2. Asphaltic Concrete (Cold-Mix): Cold mix shall conform to Subsection 4.19 "Hot-Mix Cold Laid Asphaltic Concrete." Asphaltic concrete (cold-mix) shall be used only for temporary repair and not for a final surface.

E. Joint Material: The joint material shall conform to Subsection 4.29 "Cleaning and Sealing Joints and Cracks"

III. Equipment: The Contractor shall provide the appropriate equipment that conforms to the appropriate Subsection.

IV. Construction Requirements

A. Right of Way, Utility Cut Permit: Prior to a Contractor, City Department, or utility franchised by the City cutting, boring, breaking, excavating, or making any hole, opening, ditch, displacement, depression or impairment in any dedicated public right-of-way or easement, an application for a permit must be made to the Street Superintendent for service lines. Extension of main lines must be submitted to the City Engineer. The permit requires repair and surface restoration of the right-of-way in accordance with these specifications. No work shall begin until the permit is approved. In case of emergencies, excavations shall be reported to the Street Superintendent or the Engineer and the permit process started within 24 hours or the next working day after the excavation has been made.

If the required construction is being done according to current development agreement and in accordance with development plans, agreements, no permit is required. The

Contractor, a party to a private paving agreement, shall notify the Street Superintendent of the project location(s).

Applicable sections of Chapter 4-6, Platting and Subdivision Improvement and Maintenance of the Amarillo Municipal Code shall apply also.

B. Time Limits and Other Requirements by Location

1. Alleys and Residential Streets

a) Paved and Improved surfaces: The trench shall be backfilled within 2 calendar days of completion of the utility work. Excess material excavated cannot be spread out along the alley, this material must be removed from the site.

The concrete for the trench cap shall be placed within 3 calendar days of trench backfill being complete. Flow fill from the service line to the top 2 inches of cut maybe placed in lieu of the concrete cap.

Flexible base shall be placed within 2 days of concrete cap being placed.

The final surface shall be placed within 3 calendar days of the flexible base being placed.

b) Natural surface: The trench shall be backfilled within 2 calendar days of completion of utility work. The top 8 inches of the backfill shall be at least equal in composition and density to the adjacent native material.

2. Collector Streets

a) Paved and improved surfaces: The trench shall be backfilled within 2 calendar days of completion of utility work.

The concrete for the trench cap shall be placed within 2 calendar days of trench backfill being complete. Flow fill from the service line to the top 2 inches of cut maybe placed in lieu of the concrete cap.

Flexible base shall be placed within 2 days of concrete cap being placed.

The final surface shall be placed within 3 calendar days of flexible base being placed.

b) Natural surface: The trench shall be backfilled within 2 calendar days of completion of utility work. The top 8 inches of the backfill shall be at least equal in composition and density to the adjacent native material.

3. Arterial Streets

a) Paved and improved surfaces: The trench shall be backfilled within 24 hours of completion of utility work.

The trench cap shall be placed within 2 calendar days of trench backfill being complete. Concrete compressive strength shall be more than 3000 pounds per square inch in 2 calendar days. Flow fill from the service line to the top 2 inches of cut maybe placed in lieu of the concrete cap.

Flexible base shall be placed within 2 days of concrete cap being placed.

The final surface shall be placed within 3 calendar days of flexible base being placed. Asphaltic concrete (hot-mix) may be placed when the air temperature is above 32°F and expected to rise above 40°F for at least 4 hours and the temperature of the underlying surface is above 32°F.

b) Natural surface: The trench shall be backfilled within 2 calendar days of completion of utility work. The top 8 inches of the backfill shall be constructed at least equal in composition and density to the adjacent native material.

4. Other Requirements: The construction time limits for excavation, backfill, and paving restoration are applicable to individual segments such as a city block of a new subdivision, a capital improvement project, or an isolated utility installation.

5. Temporary Surface Condition Repairs: Any asphaltic or Portland cement concrete placed during weather conditions that does not meet these specifications whether inadvertently or as directed on an emergency basis by the Street Superintendent or the Engineer shall be removed and properly replaced during acceptable weather conditions. Temporary pavement will have to be approved. The required trench cap may be constructed of compacted flexible base of a greater depth during temporary pavement restoration for alleys and residential streets. Collector and arterial streets will be plated. Permanent repairs need to done as soon as possible.

All final surfaces shall remain to grade for one year from project acceptance. The Contractor shall correct any settlement which occurs during the maintenance warranty period.

6. Exceptions: When the utility installation includes participation by any

City of Amarillo Department, the time limits shall be set on a project by project basis. The Street Superintendent and the respective City of Amarillo Department representative shall determine the time limits.

C. Existing Pavement Removal

1. **Asphaltic Concrete Removal:** Prior to removal, a smooth vertical joint shall be cut full depth and completely around the area to be removed. The joint shall be made with an acceptable tool. The pavement shall be cut back in a straight line at 2 feet from the furthermost point of excavation, shearing, caving, or removal of any other cause on each side of the ditch. If cut is not square to centerline, the hot mix will be removed to make a square cut from farthest point of the cut.

2. **Base Removal:** The pavement shall be cut back in a straight line at 1foot from the furthermost point of excavation, shearing, caving, or removal of any other cause on each side of the ditch.

3. **Portland Cement Concrete Removal:** Prior to removal, a vertical joint shall be neatly sawed completely around the area to be removed. The pavement shall be cut back in a straight line at least 6 inches from the furthermost point of excavation, shearing, caving, or removal of any other cause on each side of the ditch. The cut shall be deep enough to insure a smooth joint when the concrete is removed.

4. **Brick and Paver Removal:** Brick and pavers shall be removed and replaced as detailed in Subsection 4.21, "Brick Paving and Repair."

5. **Utility Trench Excavation:** The Contractor shall provide equipment and shoring materials that conform to Subsection 5.08, "Trench Protection." Proceed without interruption and prevent damage to existing facilities. Pipe, cable, conduit and other carriers shall be installed to prevent traffic interruption.

   Excavated material shall be properly handled and temporarily stored without undue effect on adjacent property or the right-of-way.

   Where utility excavation is near adjacent facilities and structures, the Contractor shall support and protect such facilities. When services, poles, guy wires, pipe lines or other obstructions are to be moved, the Contractor shall cooperate with the utility owner. When existing structures or utilities are damaged during construction, the Contractor shall restore the facilities to their original condition.

   The maximum allowable trench width shall be the pipe outside diameter plus 24 inches. The trench walls shall be vertical, unless other excavation

methods are approved prior to start of work.

D. Utility Installation: The Contractor shall provide equipment, labor and material as required by the appropriate utility company or City of Amarillo Department and its specifications for the proper installation.

E. Utility Trench Backfilling: Backfilling shall be accomplished by one of the following methods. The Street Superintendent or City Engineer shall approve what backfilling method shall be used prior to any project construction. The Contractor or appropriate City of Amarillo Department project representative shall contact the Street Superintendent or City Engineer prior to construction or design.

1. Excavated or imported material shall be placed in the trench in uniform layers of 8 inches or less. Each layer shall be compacted to the adjacent undisturbed soil density**.**

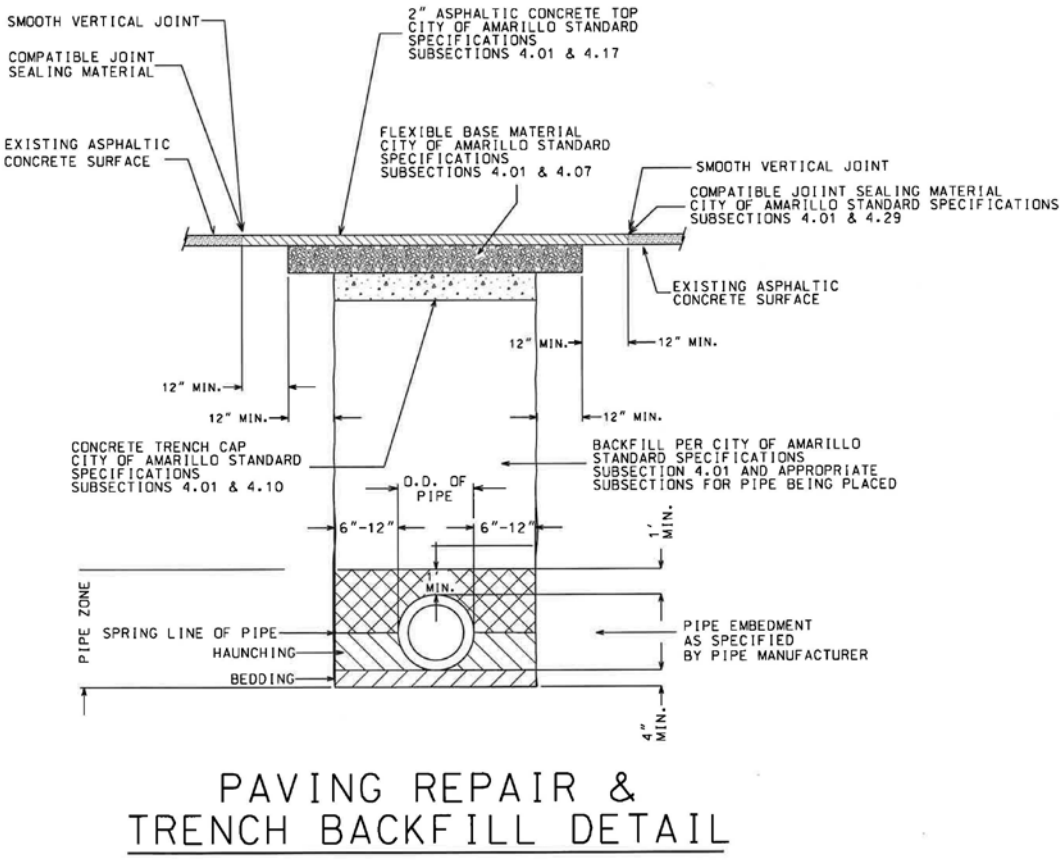
2. Sand shall be placed in the trench in uniform layers of 8 inches or less and properly compacted. Sand backfill will be limited to a maximum of 5 foot.

3. Sand or excavated material shall be placed in the trench and water jetted until trench settlement is complete. Sand backfill will be limited to a maximum of 5 foot.

4. Flowable fill in accordance with Section 4.01.II.A.4. (Preferred method)

F. Pavement Restoration: Where existing asphalt pavement is cut for any utility installation, it shall be cut in a straight line 2 feet from the furthermost point of excavation, shearing, caving, or removal of any other cause on all sides of the construction. Asphalt paving will be cut square to the centerline if the utility cut is at an angle to the centerline. Pavement will be cut square from the furthest point of the cut. Concrete paving shall be cut back 1 foot and the rest of the process for asphalt pavement shall be followed. The excavation shall be thoroughly compacted. A 6 inch thick concrete cap shall be installed on the compacted backfill, unless flowable fill is used. If flowable fill is used, backfill to 2 inches below the surface of the asphalt or the thickness of the concrete surface. Concrete compressive strengths for the shorter time to completion requirements may be obtained by adding calcium chloride to the original mix design, substituting Type II cement with Type III cement or substituting the concrete with an acceptable rapid concrete repair material. One course of 6 inch x 6 inch No. 6 welded wire fabric meeting the requirements of Subsection 4.13 "Reinforcing Steel," shall be placed 1 inch above the bottom of the cap for the entire area. For alleys and residential streets a 6 inch compacted base cap shall be placed over the concrete and existing subgrade. For arterial streets a 12 inch compacted base cap shall be placed. The base shall be overlaid with the 2 inches of hot mix as shown in Figure 1.

Figure1



Where natural or improved surface right-of-ways are scheduled for pavement by current developmental agreements or capital improvement projects, the appropriate paved surface specifications apply. The approved type of backfill material and its installation method for the utility excavation shall determine if a concrete trench cap is required. No final surface may be placed until the Street Superintendent or the Engineer has approved the utility excavation backfill and intermediate surface.

The joint between the new asphaltic concrete and the existing pavement shall be filled with a compatible joint sealing material.

The ambient air temperature requirements during concrete (asphaltic and Portland) placement shall not prevent any temporary repairs as needed in unusual situations and weather conditions. When the wind chill factor effectively reduces the ambient air temperature more than 15°F, permanent surface restoration construction shall cease and the utility cut properly barricaded until weather conditions improve. If weather conditions continue to be unacceptable for an extended period, temporary surface restoration shall be done. Conditions requiring temporary repairs shall be as determined by the Street Superintendent or the

Engineer.

The trench cap shall be maintained until the final surface is placed. The utility Contractor, utility company, and utility cut Contractor shall determine who is responsible for the trench cap prior to trench excavation. Any adjacent pavement failure attributable to the trench cap allowing to be exposed too long shall be repaired by the Contractor at his expense.

G. Surface Restoration Other Than Pavement

1. **Natural surface restoration:** Where the natural surface was soil, sod, ground cover, decorative vegetation, or other landscape improvements, the Contractor shall replace the material to its original condition before project acceptance. Natural surface restoration in vehicle traveled locations is using the existing soil to restore the right-of-way to its original condition.

2. **Improved surface restoration:** Where the improved surface was sidewalk, paving stones, driveway, or other improved surface, the Contractor shall replace the surface to its original condition before project acceptance. Improved surface restoration in vehicle traveled locations uses the existing stabilized material, flexible base or gravel to restore the right-of-way to its previous condition.

H. Construction Inspection: The City Engineer or his authorized representative shall inspect all pavement related work for utility construction in City of Amarillo right-of-way and/or easements.

I. Other Utility Placement Methods: The City Engineer or his authorized representative shall approve any tunneling, boring, or jacking method in any City of Amarillo right-of-ways or easements prior to the Contractor beginning work. This work shall comply with Subsection 10.05 "Jacking, Boring or Tunneling Pipe."

Mud formed in boring operations shall be used to fill voids around any pipe or casing in a bored excavation.

All pits or trenches needed to facilitate this work shall be excavated outside the traveled portions of the right-of-way. All pits or trenches shall be backfilled immediately after the pipe is in place.

J. Contractor Construction Responsibility: All pavement, curb and gutter, sidewalk, driveways, foliage, fences or other property improvement broken or damaged during construction whether within the work area, adjacent right-of-way, or private property shall be removed and replaced by the Contractor at his expense. In replacing damaged concrete, the Contractor shall tie to the next full and complete joint. The replaced pavement, concrete trench cap, and flexible base shall conform to these specifications.

The Contractor shall maintain all surfaces until final acceptance.

The Contractor shall maintain the pavement restoration from initial backfill through final paving. When temporary repairs are required by the Street Superintendent or Engineer, the Contractor shall furnish and place the appropriate material to backfill the utility cut. When temporary repairs are furnished by the Street Department, the Contractor shall be charged for the services and material provided.

K. Contractor Traffic Control Responsibility: The Contractor shall have an approved traffic control plan for each project by the City of Amarillo Traffic Engineer. The Contractor shall furnish, place, erect, and maintain barricades, construction signs, and other required traffic safety devices for protection of public and private property at the project site. The cost of all traffic control plan maintenance by the City of Amarillo shall be reimbursed by the Contractor.

The Contractor must request that the Traffic Engineer to close any street for construction. After approval the Contractor shall notify all the City Departments involved. The Contractor shall also notify all emergency services when the street will be closed and when it will be opened. The Contractor shall request permission from the Street Superintendent to deviate from the announced street closing times.

All proposed detours shall be approved by the Traffic Engineer prior to any construction. The Contractor may request the Traffic Engineering Department to design the detour. If the detour includes any dirt or improved surface streets, the Contractor shall provide proper dust control and passable surfaces during inclement weather. The Contractor shall maintain the detours to the satisfaction of the Street Superintendent or Engineer.

V. Measurement

If the utility construction is a part of a capital improvement project for the City of Amarillo, the particular bid documents and their specifications shall determine the work to be measured for payment.

If the utility construction is part of franchised utility improvements, the work will not be measured for payment.

If the utility construction is a City of Amarillo improvement project, the work will not be measured for payment.

VI. Payment: If measured for payment, the construction shall be paid for at the specified unit price provided by the Contractor in his proposal.

LAST PAGE OF THIS SUBSECTION

Subsection 4.02
Earthwork

I. Scope: This subsection includes the required excavation within the project limits, placement and compaction of approved earth materials for embankment, subgrade, the removal and disposal of all excavated materials not required, and the shaping and finishing of all subgrade and in conformity with the required lines, grades, and cross sections.

II. Materials

A. Soil: Excavated materials shall be used where possible within project limits. Imported soil and excavated soil shall meet the requirements below.

B. Water: Water usage shall conform to Subsection 3.04 "Requirements for Water Usage."

III. Equipment

A. General: Unless otherwise provided, the Contractor shall furnish all machinery, tools, equipment, and qualified equipment operators for the proper prosecution and completion of the work. All equipment shall be maintained in good repair and operating condition and shall be approved by the Engineer prior to use.

Suitable and sufficient compacting equipment shall be provided to obtain the required densities and stabilities complete compaction of embankment and subgrade. Compaction equipment shall obtain the required densities and stabilities. Rollers will meet requirements of Subsection 4.27 "Rolling."

Where the existing ground elevation is higher than the top of curb elevation, the embankment shall be cut back on the slopes shown on the plans.

Where the existing ground elevation is lower than the top of curb elevation, the space behind the curb shall be backfilled on a maximum slope of six to one from the top of curb unless otherwise shown on the plans.

IV. Construction Methods

A. Excavation: The Contractor shall excavate to the lines and grades as shown on the plans.

1. The Contractor will accept ownership of unsuitable or excess material and dispose of material in accordance with local, state and federal regulations at locations outside of the right of way. All rock, flexible paving, bushes, shrubs, trees, and other material not designated by a bid item in the project proposal shall be removed by the Contractor at the unit price bid for earthwork or other similar bid item. Excavation will be unclassified. The Contractor is expected to satisfy himself as to the nature of the excavation expected including the need for

rock cuts as listed below. The Contractor shall not dispose of any material in any "Flood Hazard Area" within the City limits or its extraterritorial jurisdiction. The Contractor shall be familiar with "Flood Hazard Areas" limits.

2. **Rock Cuts**: Excavate to finish grade. Manipulate and compact subgrade in accordance with Section 4.02.V.B, "Embankment" unless excavation is to clean homogenous rock at finish subgrade elevation. If excavation extends below finish subgrade, use approved embankment material compacted in accordance with Section 4.02.V.B, 'Embankment" to replace undercut material at no additional cost.

3. **Earth Cuts:** Excavate to finish subgrade. In areas where base or pavement structure will be placed on subgrade, scarify subgrade to a uniform depth at least 6 inches below finish subgrade elevation. Manipulate and compact subgrade in accordance with Section 4.02.V.B Embankment.

If unsuitable material is encountered below subgrade elevations, take corrective measures as directed. Drying required deeper than 1 foot below subgrade elevation will be paid for in accordance with pertinent Subsections of Article 10.1.1, "Change Orders" in the Uniform General Conditions for City of Amarillo Construction Contracts.

B. **Embankment*:*** Furnish, place and compact materials for construction of streets, alleys and other embankments shown on the plans. Embankment shall be fill placed below the subgrade.

1. Where embankment is to be placed adjacent to or over existing subgrade, the existing subgrade shall be scarified and recompacted with the next layer of the new embankment. The total depth of the scarified and added material shall not exceed the permissible layer depth. Apply water to achieve the uniform moisture content specified for compaction. Construct embankments to the grade shown on the plans after completion of the earthwork portion, it shall be continuously maintained to its finished section and grade until the project is accepted.

2. Backfill holes and excavations with approved material and compact. Restore the ground surface, including any material disked loose or washed out, to its original grade. Compact the ground surface by sprinkling in accordance with Subsection 4.32, "Sprinkling," and by rolling using equipment complying with Subsection 4.27, "Rolling," when directed by ODR.

3. Furnish the ODR with a submittal for a proctor for material to be used on the project whether existing material or imported material. Submittal must be approved before embankment work begins.

4. Scarify and loosen the unpaved surface areas, except rock to a depth of at least 6 inches unless otherwise shown on the plans. Do not place objectionable material in fill areas. Recompact the loosened material.

C. Subgrade: Subgrade depth shall be shown on the plans.

1. Furnish the ODR with a submittal for a proctor for material to be used on the project whether existing material or imported material. Submittal must be approved before subgrade work begins. The material must meet requirements of Table 1.

Table 1
Testing Requirements

Property	Test Method	Specification Limit
Liquid limit	Tex-104-E	≤45
Plasticity index (PI)	Tex-106-E	≤20

2. Scarify and loosen the unpaved surface areas, except rock to a depth of at least 6 inches unless otherwise shown on the plans. Do not place objectionable material in fill areas. Recompact the loosened material.

V. Compaction Methods: Compaction methods apply to both Subgrade and Embankment. Begin rolling longitudinally at the sides and proceed toward the center, overlapping on successive trips by at least 1/2 the width of the roller. Compact embankments and subgrade in accordance with the method shown on the plans**.** Prior to compaction, the layers shall not exceed 6 inches in depth where pneumatic tire rolling is to be used and shall not exceed 8 inches in depth for rolling with other types of rollers.

A. Ordinary Compaction: Use approved rolling equipment complying with Subsection 4.27 "Rolling," to compact each layer. The ODR may require specific equipment. Determine layer thickness based on the ability to meet required density, but cannot exceed thickness shown above. Before and during rolling operations, bring each layer to moisture content directed by the ODR. Compact each layer until there is no evidence of further consolidation. Maintain a level layer to ensure uniform compaction. If the required stability or finish is lost for any reason, recompact and refinish the layer at no additional expense to the City.

B. Density Control: Compact each layer to the required density using equipment that complies with Subsection 4.27 "Rolling." Determine layer thickness based on the ability to meet required density, but cannot exceed thickness shown above. Each layer is subject to testing by the ODR for density and moisture content. Where layers of unlike materials abut each other, each layer shall be featheredged for at least 50 feet or the material shall be so mixed as to prevent abrupt changes in the compacted soil. During compaction, the moisture content should not exceed 2% over the value shown on the proctor. Each layer of embankment and subgrade shall be uniform as to material and moisture content before beginning compaction. Embankment and Subgrade is required to meet 95% of dry density shown on the proctor and the

moisture content must be within +/- 2%. Proof roll in accordance with Subsection 4.31 "Proof Rolling," when shown on the plans or directed by the ODR. Correct soft spots as directed.

C. Maintenance of Moisture and Reworking: Maintain the density and moisture content once layer once it has been tested, maintain layer until next lift is ready to be placed or a surface is applied. Rework the material to obtain the specified compaction when the material loses required density or moisture.

D. Grade Tolerances: Grade to within 1/2 inch of the cross-section and 1/2 inch in 16 feet measured longitudinally.

VI. Measurement: Earthwork and Subgrade will be defined on the plans. The payment types are as follows:

A. Square yard: Square yard will be measured in its final position.

B. Cubic Yard: Cubic yard will be measured in its final position using average end area method. The volume is computed between the original ground surface or the surface upon which the embankment, excavation or subgrade is to be constructed. Shrinkage or swell factors will not be considered in determining the calculated quantities.

C. Cubic yard by Topographical Survey: The Contractor shall perform survey before excavation or embankment begins. The Contractor shall produce a survey for each monthly estimate, or the ODR shall estimate quantities and a final survey will be done at the end of the project to determine final quantity.

VII. Payment: In the square yard measurement method, the unit price shall be full compensation for excavating, hauling, compacting, shaping, fine grading, wetting, rolling, and all other work required in the excavation and embankment operation.

In the cubic yard measurement method, the appropriate excavation, embankment and subgrade items will be in the proposal.

The work performed and material furnished shall be paid for at the unit price bid for the appropriate bid item. This unit price shall be full compensation for securing and furnishing all materials involved; for all processing required; for loading, hauling, delivering, placing, and spreading for blading, shaping, and compacting to the specified grade; and for all manipulation, labor, tools, and incidentals necessary to complete the work.

LAST PAGE OF THIS SUBSECTION

Subsection 4.03
Fly Ash Treatment for Materials in Place

I. Scope: This subsection includes treating the subgrade, subbase or base (with or without asphaltic concrete pavement) by pulverizing, adding fly ash, mixing and compacting the resultant mixture to the required density. This subsection applies to one or more layers of soil, existing processed pavement, subbase, or base modified with water, and fly ash. Each layer shall conform to the lines, grades, thicknesses, and typical cross sections shown on the plans.

II. Materials

A. General: Furnish fly ash that meets the requirements of DMS-4615, "Fly Ash for Soil Treatment." Use Class CS or FS as shown on the plans.

B. Flexible Base: When required, furnish base material the meets the requirements of Subsection 4.07 "Flexible Base," for the type and grade shown on the plans.

C. Water: Water usage shall conform to Subsection 3.04 "Requirements for Water Usage."

D. Mix Design: The ODR will determine the target fly ash content. The Contractor will supply a mix design to determine optimum moisture content and density. Mix design is limited to no more that 50% of asphalt concrete pavement unless otherwise shown on the plans.

III. Equipment

A. Storage Equipment: Fly ash shall be stored and handled in closed, weather-proofed containers until immediately before distribution. If storage bins are used, they shall be completely enclosed. Materials in bags shall be stored in weatherproof buildings with adequate protection from ground dampness.

B. Water Sprinklers: Water shall be applied in accordance with Subsection 4.32 "Sprinkling."

C. Mixing Equipment: Provide pulverization equipment that:

a) Cuts and pulverizes material uniformly to the proper depth with cutters that will plane to a uniform surface over the entire width of the cut;

b) Provides a visible indication of the depth of the cut at all times;

and

c) Uniformly mixes the materials.

IV. Construction Methods

A. General: A completed stabilized subgrade, subbase, or base containing a uniform fly ash mixture free from loose or segregated areas, of uniform density, and moisture content, well bound for its full depth and with a smooth surface suitable for placing subsequent courses shall be constructed. The Contractor shall regulate his work sequence to process a sufficient quantity of material to provide full depth as shown on the plans with proper amount of fly ash; maintain the work; and rework the courses as necessary.

B. Preparation: The previous course shall be graded and shaped as required to construct the fly ash treatment for materials in place in conformance with the lines, grades, thickness, and typical cross section shown on plans. All unsuitable soils or material shall be removed and replaced with acceptable material.

C. Weather Limitations: The stabilized mixture shall not be constructed while the atmospheric temperature is below 40°F or when conditions indicate that the temperature may fall below 40°F prior to completion of the operation. The operation shall not be started when weather conditions are foggy or rainy, or when soil, subgrade or base is frozen.

D. Pulverization: The material to be stabilized shall be pulverized until 100% by weight shall pass a 1 inch sieve and 80% shall pass a No. 4 sieve, exclusive of gravel or stone retained on the No. 4 sieve.

E. Preparation of Subgrade or Existing Base for Treatment: When called for in plans, before treating, remove existing asphalt concrete pavement, before treating in accordance with pertinent subsections in the plans or as directed by the ODR. Shape existing material to typical sections shown on the plans.

When shown on the plans or directed by the ODR, proof-roll the roadbed in accordance with Subsection 4.31, "Proof Rolling," before pulverizing or scarifying existing material. Correct soft spots as directed.

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

F. Applying and Mixing in Place: Fly ash shall be uniformly spread by an approved method over an area only as large as mixing operations can be completed during the same work day. Apply percentage shown in plans. Any fly ash that has been displaced shall be replaced before mixing is started. Do not spread fly ash with a motor grader. After fly ash has been applied, it shall be mixed with the material. Mixing shall continue until the stabilization material has been sufficiently blended with

the material to form a homogeneous mixture. Do not apply fly ash when wind conditions, in the opinion of the ODR, cause blowing fly ash to become dangerous to traffic or objectionable to adjacent property owners.

G. Compaction: Prior to compaction, the mixture shall be in a loose condition for its full depth. The loose mixture shall be uniformly compacted to the specified density within 6 hours. Shaping may be required to obtain uniform compaction and required grade and cross section. The in-place density for stabilized subgrade or subbase shall not be less than 95% of the final mixture's Standard Proctor. The in place density for stabilized base shall not be less than 100% of the final mixture's Standard Proctor. Final density mixture testing is the responsibility of the City of Amarillo.

H. Finishing: During and after compaction, the surface of the mixture shall be shaped to the required lines, grades, and cross section. Scarifying may be used to remove any tire imprints or smooth surface imperfections left by equipment. The resulting surface shall then be compacted to the specified density to obtain a dense smooth surface that is free from compaction planes, cracks, ridges, or loose material.

The surface of the mixture shall be maintained at optimum moisture content during the finishing operation. Any portion of the mixture that varies substantially from the specified density shall be removed and replaced by the Contractor.

I. Construction Joints: At the end of each days run, a transverse construction joint shall be formed by a header or by cutting back into the compacted material to form a true transverse vertical face. The construction joints may be protected by the placing, spreading, and compacting of stabilized material without injury to the work previously laid. Care shall be exercised to ensure thorough compaction of the stabilized material immediately adjacent to all construction joints. When it is necessary to operate and/or turn any equipment on the completed stabilized course, sufficient protection and cover shall be provided to prevent damage to the finished surface.

J. Protection and Curing: After the stabilized material has been finished, it shall be protected against drying for a period of no less than 3 days or until the next paving course is placed by applying bituminous material or maintaining the surface in a thorough and continuously moist condition. The curing method shall begin as soon as possible, but no later than 6 hours after finishing. When the air temperature may fall below 35°F, sufficient protection from freezing shall be given the stabilized material.

K. Construction Limitations: The Contractor shall modify construction procedures when any phase is interrupted for more than 30 minutes or the uncompacted mixture is out of the moisture content tolerances. All material designated to be reconstructed shall be at the Contractor's expense.

L. Maintenance: The Contractor shall be required to maintain the entire stabilized material satisfactorily. Maintenance shall include immediate repairs of any defects that may occur either before or after the stabilization material is applied. The work shall be repeated as often as necessary to keep the area intact at all times. Repairs shall be made in a manner that will ensure restoration of a uniform surface and

the durability of the area repaired. Faulty work must be replaced for the full depth of the treatment. Any thin areas shall be remedied by replacing the material for the full depth of the treatment rather than by the addition of a thin layer of stabilized material to a completed surface.

V. Measurement

A. Stabilized Subgrade, Subbase, or Base: The stabilized material shall be measured in square yards of completed and accepted finished surface.

B. Fly Ash: The amount of fly ash shall be measured by the ton installed.

C. Flex Base: Flex base shall be measured by the Square Yard of material required.

VI. Payment

A. Stabilized Subgrade, Subbase, or Base: Payment shall be made at the contract unit price per square yard for stabilized material. This price shall be full compensation for furnishing all materials, all preparation, delivering, placing, and mixing of these materials, except for the stabilization material used, and for all labor, equipment, tools and incidentals necessary to complete this portion of the project. Where subgrade is constructed under this Contract, correction of soft spots in the subgrade or existing base will be at contractor's expense. Where subgrade is not built under this Contract, correction of soft spots in the subgrade or existing base will be in accordance with pertinent subsections or Article 10.1.1of the Uniform General Conditions for City of Amarillo Civil Construction Contracts.

B. Fly Ash: Payment shall be made at the contract unit price per ton of fly ash for the calculated amount for planned thickness. This price shall be full compensation for furnishing this material and for all delivery, placing, and incorporation of this material, and for all labor, equipment, tools, and incidentals necessary to complete the work. Fly ash used for reworking a section will not be part for.

C. Flexible Base: Payment shall be made in accordance with Subsection 4.05, "Flexible Base." Mixing, spreading, blading, shaping, compacting, and finishing will be considered part of this subsection.

LAST PAGE OF THIS SUBSECTION

Subsection 4.04
Lime Stabilized Subgrade

I. Scope: This subsection includes stabilizing the subgrade by mixing lime with the subgrade material and compacting the mixed material. The stabilized subgrade shall be constructed in accordance with the plans and to the lines and grades as established by the ODR or Engineer.

II. Materials: Furnish uncontaminated materials of uniform quality that meet the requirements of the plans and subsections. Provide a submittal of the lime source. The ODR may sample and test project materials at any time.

A. Lime: Furnish lime that meets the requirements of DMS-6350 "Lime and Lime Slurry," and DMS-6330, "Lime Sources Prequalification of Hydrated Lime and Quicklime." Use hydrated lime, commercial lime slurry, or quicklime, as shown in the plans. When furnishing quicklime, provide it in bulk.

B. Water: Water usage shall conform to Subsection 3.04, "Requirements for Water Usage."

C. Mix Design: The ODR will determine the target lime content. The contractor will submit a proctor of the lime treated material to determine density and moisture content.

III. Equipment: Store quicklime and dry hydrated lime in closed weatherproof containers. Provide rollers in accordance with Subsection 4.27, "Rolling." Provide proof rollers in accordance with Subsection 4.31, "Proof Rolling." Provide Sprinkling according to Subsection 4.32 "Sprinkling."

A. Slurry Equipment: Use slurry tanks equipped with agitation devices to slurry hydrated lime or quicklime on an approved site. The ODR may approve other slurrying methods. Provide a pump for agitating the slurry when the distributor truck is not equipped with an agitator. Equip the distributor truck with a sampling device in accordance with Tex-600-J, Part I, when using commercial lime slurry.

B. Pulverization Equipment: Provide pulverization equipment that:

1. Cuts and pulverizes material uniformly to the proper depth with cutters that plane to a uniform surface over the entire width of the cut;

2. Provides a visible indication of the depth of cut at all times; and

3. Uniformly mixes the material.

IV. Construction Methods: Mix and compact lime stabilized subgrade containing a uniform lime mixture free from loose or segregated areas, of required uniform density and moisture content, well bound from top to bottom, and with a smooth hard surface is required.

A. Preparation of Subgrade for Treatment*:* Shape existing material to conform to typical sections, lines, and grades shown on the plans.

When shown on the plans or directed, proof roll the roadbed in accordance with Subsection 4.31, "Proof Rolling," before pulverizing or scarifying existing material. Correct soft spots as directed.

B. Pulverization: Scarify or pulverize existing material after shaping so that 100% of the material passes a 1 inch sieve. If material cannot be uniformly processed to required depth in a single pass, excavate and windrow the material to expose a secondary grade to achieve processing to plan depth.

C. Application of Lime: Uniformly apply lime using dry or slurry placement as shown on the plans or directed. Add lime at the percentages shown in the plans. Apply lime only on area where mixing can be completed during the same day.

Lime application can begin only when air temperature is at least 40°F and rising or is at least 50°F. Discontinue operation if temperature is 50°F and falling. The temperature will be taken in the shade and away from artificial heat. Suspend application when the ODR or Engineer determines that weather conditions are unsuitable.

Minimize dust and scattering of lime by wind. Do not apply lime when wind conditions, in the opinion of the ODR, cause blowing lime to become dangerous to traffic or objectionable to adjacent property owners. When pebble quicklime is placed dry, mix the material and lime thoroughly at the time of lime application.

1. Dry Placement: Before applying lime, bring the prepared roadway to approximately optimum moisture content in accordance with Subsection 4.32, "Sprinkling." Distribute the required quantity of hydrated lime or pebble grade quicklime with approved equipment. Only hydrated lime may be distributed by bag. Do not use a motor grader to spread hydrated lime.

2. Slurry Placement: Provide slurry free of objectionable materials, at or above the approved minimum dry solids, and with a uniform consistency that will allow ease of handling and uniform application. Deliver commercial lime slurry to the jobsite or prepare lime slurry at the jobsite or other approved

location by using hydrated lime or quicklime, as specified.

Distribute slurry uniformly by making successive passes over a measured section of roadway until the specified lime content is reached. Uniformly spread the residue from quicklime slurry over the length of the roadway being processed.

D. Mixing: Begin mixing within 6 hours of application of lime. Hydrated lime that has been exposed to open air for a period of 6 hours or more, or to moisture for any length of time, will not be accepted for payment. Thoroughly mix the material and lime using approved equipment. Allow the mixture to mellow for 1 to 4 days, as directed. When pebble quicklime is used, allow the mixture to mellow 2 to 4 days, as directed. Sprinkle the treated materials during the mixing and mellowing operation, to achieve adequate hydration and proper moisture content. After mellowing, resume mixing until a homogeneous mixture is obtained.

E. Compaction: Compaction of the mixture shall begin immediately after mixing. The material shall be aerated or sprinkled as necessary to provide the optimum moisture. Compaction shall begin at the bottom and shall continue until the entire depth of mixture is uniformly compacted to required density. When the rolling develops irregularities that exceed 1/2 inch when tested with a 16 foot straightedge, the irregular surface shall be loosened and then refilled with the same kind of material as that used in constructing the course and again rolled as required by these provisions. Along places inaccessible to roller, the material shall be tamped thoroughly with mechanical or hand tampers.

The "Density Control" method of compaction for stabilized subgrade shall apply as follows: The material shall be sprinkled as required and compacted to the extent necessary to provide not less than 95% of the Standard Proctor density for the stabilized material. In addition to the requirements specified for density, the full depth of the material shown on the plans shall be compacted to the extent necessary to remain firm and stable under construction equipment. After each section is completed, tests as necessary will be made by the Engineer. If the material fails to meet the density requirements, it shall be re-worked as necessary to meet these requirements. 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 section shown on the plans and to the established lines and grades.

Should the stabilized material due to any reason or cause, lose the required stability, density, and finish before the next course is placed or the work is accepted, it shall be reworked and refinished at no cost to the City. When a section is reworked within 72 hours after completion, rework the section to provide required density. When a section is reworked more than 72 hours after completion, add additional lime at 25% of

the percentage determined. Reworking includes loosening, adding material or removing unacceptable material if necessary, mixing, compacting and finishing. Density must attain not less than 95% of the Standard Proctor density for the stabilized material and ± 2 % moisture content of the proctor.

F. Finishing: Immediately after completing compaction, clip, skin or tight blade the surface of the lime treated subgade with a maintainer or subgrade trimmer to a grade. Roll the clipped surface with a pneumatic tire roller until a smooth surface is attained. Shape and maintain the subgrade in conformity with the typical section, lines and grades on the plans.

G. Curing: Cure for a minimum of 2 days by sprinkling in accordance with Subsection 4.32 "Sprinkling." Maintain moisture during curing. Base course must be applied within 14 days or section will have to be reworked.

V. Measurement:

A. Lime: For each load of dry lime placed in the slurry tank, or truck, a weight ticket from an approved weighing station showing the net weight of each load shall be given to the Project Representative. The Contractor may provide at the project site a set of approved standard platform truck scales. Scales must conform to requirements of Subsection 4.26 "Weighing and Measuring Equipment". When lime is furnished in bags, indicate the manufacturer's certified weight. Bags varying by more than 5% will be rejected. At random, 10 bags will be weighed, all bags must be at least certified weight.

1. Hydrated Lime:

a) Dry. Lime will be measured by the ton (dry weight).

b) Slurry. Lime slurry will measured by the ton (dry weight) of the hydrated lime used to prepare the slurry.

2. Commercial Lime Slurry: Lime slurry will be measured by the ton (dry weight) as calculated from the minimum percent dry solids of the slurry, multiplied by the weight of the slurry in tons delivered.

3. Quicklime:

a) Dry. Lime will be measured by the ton (dry weight) of the quicklime.

b) 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 equivalent hydrated lime.

B. Lime Treatment: Lime treatment will be measured by the square yard of surface area shown on the plans.

VI. Payment: Work performed and materials furnished as prescribed by this subsection and measured as provided under "Measurement" will be paid for at the unit price bid per ton for lime and at the unit price bid per square yard for lime stabilized subgrade, which prices shall be full compensation for furnishing all labor, materials, tools, equipment, for loosening, mixing and pulverizing, spreading, shaping, all hauling and freight involved, and all incidentals necessary to complete the work.

LAST PAGE OF THIS SUBSECTION

Subsection 4.05
Cement Kiln Dust Stabilized Subgrade

I. Scope: This subsection includes stabilizing the subgrade by mixing cement kiln dust (CKD) with the subgrade material and compacting the mixed material. The stabilized subgrade shall be constructed in accordance with the plans and to the lines and grades as established by the ODR or Engineer.

II. Materials: Furnish uncontaminated materials of uniform quality that meet the requirements of the plans and subsections. Provide a submittal of the CKD source. The ODR may sample and test project materials at any time.

A. Cement Kiln Dust: Furnish CKD that meets the requirements of ASTM Specification D5050-08 "Standard Guide for Commercial Use of Lime Kiln Dusts and Portland Cement Kiln Dusts." CKD must be from a pre-calcinated process plant. CKD must be from a pre-approved source. Use CKD, as shown in the plans.

B. Water: Water usage shall conform to Subsection 3.04 "Requirements for Water Usage."

C. Mix Design: The ODR will determine the target CKD content. The contractor will submit a proctor of the CKD treated material to determine density and moisture content.

III. Equipment: Store CKD in closed weatherproof containers. Provide rollers in accordance with Subsection 4.27 "Rolling." Provide proof rollers in accordance with Subsection 4.31 "Proof Rolling." Provide Sprinkling according to Subsection 4.32 "Sprinkling."

Provide pulverization equipment that:

A. Cuts and pulverizes material uniformly to the proper depth with cutters that plane to a uniform surface over the entire width of the cut;

B. Provides a visible indication of the depth of cut at all times; and

C. Uniformly mixes the material.

IV. Construction Methods: Mix and compact CKD stabilized subgrade containing a uniform CKD mixture free from loose or segregated areas, of required uniform density and moisture content, well bound from top to bottom, and with a smooth hard surface is required.

A. Preparation of Subgrade for Treatment*:* Shape existing material to conform to typical sections, lines, and grades shown on the plans.

When shown on the plans or directed, proof roll the roadbed in accordance with Subsection 4.31 "Proof Rolling," before pulverizing or scarifying existing material. Correct soft spots as directed.

B. Pulverization: Scarify or pulverize existing material after shaping so that 100% of the material passes a 2 inch sieve. If material cannot be uniformly processed to required depth in a single pass, excavate and windrow the material to expose a secondary grade to achieve processing to plan depth.

C. Application of Cement Kiln Dust: Uniformly apply CKD as shown on the plans or directed. Add CKD at the percentages shown in the plans. Apply CKD only on area where mixing can be completed during the same day.

CKD application can begin only when air temperature is at least 40°F and rising or is at least 50°F. Discontinue operation if temperature is 50°F and falling. The temperature will be taken in the shade and away from artificial heat. Suspend application when the ODR or Engineer determines that weather conditions are unsuitable.

Minimize dust and scattering of CKD by wind. Do not apply CKD when wind conditions, in the opinion of the ODR, cause blowing CKD to become dangerous to traffic or objectionable to adjacent property owners.

Dry Placement: Before applying CKD, bring the prepared roadway to approximately optimum moisture content in accordance with Subsection 4.32 "Sprinkling." Distribute the required quantity of CKD with approved equipment. A motor grader may be utilized to spread the CKD but cannot be used for the blending process.

D. Mixing: Begin mixing within 2 hours of application of CKD. CKD that has been exposed to open air for a period of 6 hours or more, or to moisture for any length of time, will not be accepted for payment. Thoroughly mix the material and CKD using approved equipment.

E. Compaction: Compaction of the mixture shall begin immediately after mixing and must be completed with 6 hours of initial mixing. The material shall be aerated

or sprinkled as necessary to provide the optimum moisture. Compaction shall begin at the bottom and shall continue until the entire depth of mixture is uniformly compacted to required density. When the rolling develops irregularities that exceed 1/2 inch when tested with a 16 foot straightedge, the irregular surface shall be loosened and then refilled with the same kind of material as that used in constructing the course and again rolled as required by these provisions. Along places inaccessible to roller, the material shall be tamped thoroughly with mechanical or hand tampers.

The "Density Control" method of compaction for stabilized subgrade shall apply as follows: The material shall be sprinkled as required and compacted to the extent necessary to provide not less than 95% of the Standard Proctor density for the stabilized material. In addition to the requirements specified for density, the full depth of the material shown on the plans shall be compacted to the extent necessary to remain firm and stable under construction equipment. After each section is completed, tests as necessary will be made by the Engineer. If the material fails to meet the density requirements, it shall be re-worked as necessary to meet these requirements. 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 section shown on the plans and to the established lines and grades.

Should the stabilized material due to any reason or cause, lose the required stability, density, and finish before the next course is placed or the work is accepted, it shall be reworked and refinished at no cost to the City. When a section is reworked add additional CKD at 25% of the percentage determined. Reworking includes loosening, adding material or removing unacceptable material if necessary, mixing, compacting and finishing. Density must attain not less than 95% of the Standard Proctor density for the stabilized material and ± 2 % moisture content of the proctor.

F. Finishing: Immediately after completing compaction, clip, skin or tight blade the surface of the CKD treated subgrade with a maintainer or subgrade trimmer to a grade. Roll the clipped surface with a pneumatic tire roller until a smooth surface is attained. Shape and maintain the subgrade in conformity with the typical section, lines and grades on the plans.

G. Curing: Cure for a minimum of 2 days by sprinkling in accordance with Subsection 4.32 “Sprinkling.” Maintain no less than 2% of optimum moisture content during curing. Base course must be applied within 14 days or section will have to be reworked.

IV. Measurement: For each load of CKD, a weight ticket from an approved weighing station showing the net weight of each load shall be given to the Project Representative. The Contractor may provide at the project site a set of approved standard platform truck scales. Scales must conform to requirements of Subsection 4.26 “Weighing and Measuring Equipment”.

A. **Cement Kiln Dust:** CKD will be measured by the ton (dry weight).

B. **Cement Kiln Dust Treatment:** CKD treatment will be measured by the square yard of surface area shown on the plans.

V. **Payment:** Work performed and materials furnished as prescribed by this subsection and measured as provided under "Measurement" will be paid for at the unit price bid per ton for CKD and at the unit price bid per square yard for CKD stabilized subgrade, which prices shall be full compensation for furnishing all labor, materials, tools, equipment, for loosening, mixing and pulverizing, spreading, shaping, all hauling and freight involved, and all incidentals necessary to complete the work.

LAST PAGE OF THIS SUBSECTION

Subsection 4.06
Cement Treatment (Road-Mixed)

I. Scope: Mix and compact cement, water, and subgrade or base (with or without asphalt concrete pavement) in the roadway.

II. Materials: Furnish uncontaminated materials of uniform quality that meet the requirements of the plans and specifications. Notify the ODR or Engineer of the proposed material sources and of changes to material sources. The ODR may verify that the subsection requirements are met before the sources can be used. The ODR may sample and test project materials at any time before compaction. Use Tex-100-E for material definitions.

A. Cement: Furnish hydraulic cement that meets the requirements of DMS-4600, "Hydraulic Cement," and TxDOT's Hydraulic Cement Quality Monitoring Program (HCQMP). Sources not on the HCQMP will require the contractor testing and approval by ODR before use.

B. Flexible Base: Furnish base material that meets the requirements of Subsection 4.07, "Flexible Base," for the type and grade shown on the plans, before the addition of cement.

C. Water: Water usage shall conform to Subsection 3.04 "Requirements for Water Usage."

D. Asphalt: When permitted for curing purposes, furnish asphalt or emulsion that meets the requirements of Subsection 4.23, "Asphalts, Oils, and Emulsions."

E. Mix Design: The contractor will submit a proctor for approval to determine the target cement content and optimum moisture content to produce a stabilized mixture that meets the design strength requirements. The mix will be designed in accordance with Tex-120-E or will be based on prior experience with the project materials. The ODR or Engineer may use Tex-120-E to verify the Contractor's proposed mix design before acceptance. Submit additional mix designs or partial designs necessitated by changes in the material or requests by the Contractor and approved by the Engineer. When treating existing materials, limit the amount of asphalt concrete pavement to no more than 50% of the mix.

III. Equipment: Provide machinery, tools, and equipment necessary for proper execution of the work. Provide rollers in accordance with Subsection 4.27, "Rolling."

A. Cement Storage Facility: Store cement in closed, weatherproof containers.

B. Dry Cement Distribution Equipment: Provide equipment to spread cement evenly across the area to be treated. Provide equipment with a rotary vane feeder when shown on the plans.

C. Pulverization Equipment: Provide pulverization equipment that:

1. Cuts and pulverizes material uniformly to the proper depth with cutters that will plane to a uniform surface over the entire width of the cut;

2. Provides a visible indication of the depth of cut at all times; and

3. Uniformly mixes the materials.

IV. 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.

A. Preparation of Subgrade or Existing Base for Treatment: Before treating, remove existing asphalt concrete pavement if required in accordance with pertinent subsections and the plans or as directed. Shape existing material in accordance with applicable bid items to conform to the typical sections shown on the plans and as directed. Correct soft spots as directed. For borrow sources, provide proctor before beginning hauling operations. When new base is required to be mixed with existing base, deliver, place, and spread the new material in the required amount per station. Manipulate and thoroughly mix new base with existing material to provide a uniform mixture to the specified depth before shaping.

B. Pulverization: Pulverize or scarify existing material after shaping so that 100% passes a 2-1/2-inch sieve. If the material cannot be uniformly processed to the required depth in a single pass, excavate and windrow the material to expose a secondary grade to achieve processing to plan depth.

C. Application of Cement: Uniformly apply cement using dry placement. Add cement at the percentage determined in Section 4.06.II.5, "Mix Design." Apply cement only on an area where mixing, compacting, and finishing can be completed during the same working day. Start cement application only when the air temperature is at least 35°F and rising or is at least 40°F. The temperature will be

taken in the shade and away from artificial heat. Suspend application when the ODR or Engineer determines that weather conditions are unsuitable. Before applying cement, bring the prepared roadway to approximately optimum moisture content. When necessary, sprinkle in accordance with Subsection 4.32, "Sprinkling." Distribute the required quantity of dry cement with approved equipment. Minimize dust and scattering of cement by wind. Do not apply cement when wind conditions, in the opinion of the ODR or Engineer, cause blowing cement to become dangerous to traffic or objectionable to adjacent property owners.

D. Mixing: Thoroughly mix the material and cement until a homogeneous mixture is obtained. Sprinkle the treated materials during the mixing operation to maintain optimum mixing moisture. Spread and shape the completed mixture in a uniform layer. After mixing, the ODR or Engineer may sample the mixture and test in accordance with Tex-101-E, Part III to determine compliance with the gradation requirements in Table 1. The contractor will sample the mixture to verify the design strength is met in accordance with Tex-120-E and adjust cement content to achieve the target strength for work going forward.

Table 1
Gradation Requirements Minimum % Passing

Sieve Size	Base	Subgrade
1-3/4 inch	100	100
3/4 inch	85	85
No. 4	–	60

a) Compaction: Compact the mixture in one lift using density control. Complete compaction within 2 hours after the application of water to the mixture of material and cement. Sprinkle or aerate the treated material in accordance with Subsection 4.32, "Sprinkling," to adjust the moisture content during compaction so that it is within 2.0 percentage points of optimum as determined by Tex-120-E. Measure the moisture content of the material in accordance with Tex-115-E or Tex-103-E during compaction daily and report the results the same day to the ODR. Adjust operations as required. Begin rolling longitudinally at the sides and proceed towards the center, overlapping on successive trips by at least one-half 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. Before completion the ODR will select locations of tests in each application area to be tested by the contractor for depth in accordance with Tex-140-E. Correct areas deficient by more than 1/2 inch in thickness or

more than 1/2% in target cement content as required, reshaping, recompacting, and refinishing at the Contractor's expense. Remove or rework areas that lose required stability, compaction, or finish. When a section is reworked more than 4 hours after completion of compaction, add additional cement. Provide additional work and material at the Contractor's expense.

(1) Ordinary Compaction: 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: Compact to at least 95% of the maximum density of the proctor of the subgrade. Compact to at least 100% of the maximum density of the proctor on base courses the Contractor will determine roadway density in accordance with Test Method Tex-115-E and will verify strength in accordance with Tex-120-E and adjust cement content to achieve the target strength for work going forward. Remove material that does not meet density requirements or rework by adding the target cement content, reshaping, recompacting and refinishing at the Contractor's expense. The ODR may accept the section if no more 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.

b) Finishing: Immediately after completing compaction, clip, skin, or tight-blade the surface of the cement treated material with a maintainer or trimmer to grade. 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. Finish grade of constructed subgrade to within 0.1 foot in the cross section and 0.1 foot in 16 feet measured longitudinally. Correct grade deviations of constructed base greater than 1/4 inch in 16 feet measured longitudinally or greater than1/4 inch over the entire width of the cross-section in areas where surfacing is to be placed. Remove excess material, reshape and roll with a pneumatic-tire roller. Correct if material is more than 1/4 inch low. Do not surface patch.

E. Microcracking: When shown on the plans, maintain moisture content of the finished cement treated base for a period of 24 to 48 hours. During this time, but not sooner than 24 hours, roll the finished course with a vibratory roller to induce

microcracking. The vibratory roller must be in accordance with Subsection 4.27 "Rolling," with a static weight equal to or more than 12 tons and the vibratory drum must be not less than 20 inches wide. The roller must travel at a speed of 12 miles per hour, vibrating at maximum amplitude, and make 2 to 4 passes with 100% coverage exclusive of the outside 1 foot of the surface crown, unless otherwise directed by the ODR. Additional passes may be required to achieve the desired crack pattern as directed. Notify the ODR 24 hours before the microcracking begins.

F. Curing: Cure for at least 3 days by sprinkling in accordance with Subsection 4.32, "Sprinkling," or by applying an asphalt material shown in Subsection 4.23 "Asphalts, Oils, and Emulsions" at the rate of 0.05 to 0.20 gallons per square yard. Maintain the moisture content during curing at no lower than 2 percentage points below optimum. Continue curing until placing another course or opening the finished section to traffic.

V. Measurement

A. Cement: Cement will be measured by the ton (dry weight). When cement is furnished in trucks, the weight of cement will be determined on certified scales, or the Contractor must provide a set of standard platform truck scales at a location approved by the ODR. Scales must conform to the requirements of Subsection 4.26, "Weighing and Measuring Equipment." When cement is furnished in bags, indicate the manufacturer's certified weight. Bags varying more than 5% from that weight may be rejected. The average weight of bags in any shipment, as determined by weighing 10 bags taken at random, must be at least the manufacturer's certified weight.

B. Cement Treatment: Cement treatment will be measured by the square yard of surface area. The dimensions for determining the surface areas are established by the widths shown on the plans and lengths measured at placement.

VI. Payment: The work performed and materials furnished in accordance with this Subsection and measured as provided under "Measurement" will be paid in accordance with Section 4.06.V.a, "Cement," or Section 4.06.V.b, "Cement Treatment." Furnishing and delivering new base will be paid for in accordance with Subsection 4.07 "Flexible Base." Mixing, spreading, blading, shaping, compacting, and finishing new or existing base material will be paid for under Section 4.06.V.a, "Cement Treatment." Removal and disposal of existing asphalt concrete pavement will be paid for in accordance with pertinent subsections. Sprinkling and rolling, except proof-rolling, will not be paid for directly but will be subsidiary to this Subsection, unless otherwise shown on the plans. Microcracking, when shown, will not be measured, but will be subsidiary to the subsection. Correction of

soft spots in the subgrade or existing base will be at the Contractor's expense. Asphalt used for curing will not be paid for directly, but will be subsidiary to this Item.

a) Cement: Cement will be paid for at the unit price bid for "Cement." This price is full compensation for materials, delivery, equipment, labor, tools, and incidentals.

b) Cement Treatment. Cement treatment will be paid for at the unit price bid for "Cement Treatment (Existing Material)," "Cement Treatment (New Base)," or "Cement Treatment (Mixing Existing Material and New Base)," for the depth specified. No additional payment will be made for thickness or width exceeding that shown on the plans. This price is full compensation for shaping existing material, loosening, mixing, pulverizing, providing cement, spreading, applying cement, compacting, finishing, curing, curing materials, blading, shaping and maintaining shape, replacing mixture, disposing of loosened materials, processing, hauling, preparing secondary subgrade, water, equipment, labor, tools, and incidentals.

LAST PAGE OF SECTION

Subsection 4.07
Flexible Base

I. Scope: This subsection provides a foundation course composed of flexible base.

II. Materials: Furnish uncontaminated materials of uniform quality that meet the requirements of the plans and specifications. Notify the ODR or Engineer of the proposed material sources and of changes to material sources. The ODR may sample and test project materials at any time throughout the duration of the project to assure specification compliance. Use Tex-100-E for material definitions.

A. Aggregate: Furnish aggregate of the type and grade shown on the plans and meeting the requirements of Table 1. Each source must meet Table 1 requirements for gradation, liquid limit, plasticity index, and wet ball 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.

Material Requirements
Table 1

Property	Test Method	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5
Master gradation sieve size (% retained)	Tex-110-E				As shown on plans	
2-1/2 in.				0		0
1-3/4 in.		0-10	0-10	0-10		0-5
7/8 in.		10-35	10-35	-		10-35
3/8 in.		30-65	30-65	-		35-65
No. 4		45-75	45-75	45-75		45-75
No. 40		65-90	65-90	50-85		70-90
Liquid Limit, max[1]	Tex-104-E	40	40	40	As shown on the plans	35
Plasticity Index, max[1]	Tex-106-E	12	12	12		10
Plasticity Limit, min[1]			As shown on the plans			
Wet ball mill, % max	Tex-116-E	45	45	-	As shown on the plans	40
Wet ball mill, % max Increase passing the No. 40 sieve		20	20	-		20
Min. compressive strength, psi Lateral pressure 0 psi Lateral pressure 3 psi Lateral pressure 15 psi	Tex-117-E	 35 - 175	 - - -	 - - -	As shown on the plans	 - 90 175

[1]Determine plastic index in accordance with ASTM D427 (linear shrinkage) when liquid limit is unattainable as defined in ASTM D4318.

1. Material Tolerances: The ODR 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. No one single test may exceed the allowable limit by more than 2 points.

2. Material Types: Do not use fillers or binders unless approved. Furnish the type specified on the plans in accordance with the following:

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.

Type B: Crushed or uncrushed gravel. Blending of 2 or more sources is allowed.

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 Tex-460-A, Part 1. Blending of 2 or more sources is allowed.

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 Subsection 4.07.II.E "Recycled Material (including crushed concrete) Requirements", and be managed in a way to provide for uniform quality. The ODR may require separate dedicated stockpiles in order to verify compliance. Crushed concrete shall be free of debris and contaminants.

Type E: Caliche.

(1) Recycled Materials: Recycled asphalt pavement (RAP) and other recycled materials may be used. Request approval to blend 2 or more sources of recycled materials. Provide recycled materials that have a maximum sulfate content of 3,000 ppm when tested in accordance with Tex-145-E, including crushed concrete, the final product will be subject to the requirements of Table 1 for the grade specified. Certify compliance with DMS-11000, "Evaluating and Using Nonhazardous Recyclable Materials Guidelines," for Contractor furnished materials. In addition, recycled materials must be free from reinforcing steel and other objectionable material and must have at most 1.5% deleterious material when tested in accordance with Tex-413-A. For RAP, do not exceed a maximum percent loss from decantation of 5.0% when tested in accordance with Tex-406-A. Test RAP without removing the asphalt. Remove Contractor-owned recycled materials from the project and dispose of them in accordance with federal, state, and local regulations before project acceptance.

B. Water: Water usage shall conform to Subsection 3.04 "Requirements for Water Usage."

C. Material Sources: Expose the vertical faces of all strata of material proposed for use when non-commercial sources are used. Secure and process the material by successive vertical cuts extending through all exposed strata. The ODR reserves the right to inspect the pit location at any time throughout the project to ensure compliance with all material processing and handling requirements. Any observed or documented mishandling of materials in the pit or stockpile may be cause for rejection of that source, at the discretion of the ODR. All cost for sampling and acceptance testing required as a result of rejecting the material source shall be the responsibility of the Contractor.

III. Equipment

A. Compaction: Provide machinery, tools, and equipment necessary for proper execution of the work. Provide rollers in accordance with Subsection 4.27 "Rolling".

B. Pulverization Equipment: Provide pulverization equipment that :

1. Cuts and pulverizes material uniformly to the proper depth with cutters that plane to a uniform surface over the entire width of the cut;

2. Provides a visible indication of the depth of cut at all times; and

3. Uniformly mixes the materials.

IV. 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. 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 feet and 16 feet. 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. The Contractor will perform additional sampling and testing required as a result of adding or removing material. Haul approved flexible base in clean trucks. Deliver the required quantity to each 100 foot station or designated stockpile site. Prepare stockpile sites as directed. When delivery is to the 100 foot station, manipulate in accordance with the applicable subsections.

A. Preparation of Subgrade or Existing Base: Remove or scarify existing asphalt concrete pavement in accordance with Subsection 4.30, "Removing Treated and Untreated Base and Asphalt Pavement." Shape the subgrade or existing base to conform to the typical sections. Base material shall not be laid upon frozen subgrade. Curb and gutter shall be constructed and cured sufficiently prior to base being placed against curb and gutter. 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. Correct soft spots.

B. Placing: Spread and shape flexible base into a uniform layer with an approved spreader the same day as delivered. Construct layers to the thickness shown on the plans. Maintain the shape of the course. Control dust by sprinkling. Correct or replace segregated areas as directed, at no additional expense to the City. Flexible base shall be laid and compacted in courses no less than 4 inches or no more than 6 inches. Place successive base courses and finish using the same construction methods required for the first course.

C. Processing Existing Base: Before scarifying, clean the existing base of objectionable materials by blading, brooming or other methods, unless otherwise shown on the plans. Perform this work in accordance with applicable Subsections.

1. Types of Work:

- **a) Type A:** Scarifying only.
- **b) Type B:** Scarifying, salvaging, and stockpiling.
- **c) Type C:** Scarifying and reshaping.
- **d) Type D:** Refinishing.

2. Scarifying: Loosen and break existing base material, with or without existing asphaltic concrete pavement. Remove or scarify existing asphalt concrete pavement in accordance with Subsection 4.30, "Removing Treated and Untreated Base and Asphalt Pavement," when shown on the plans. Scarify existing material for its full width, unless otherwise shown on the plans. Break material into particles of not more than 2-1/2 inches.

3. Salvaging: Remove the existing base material and stockpile. Perform salvage operations while maintaining proper drainage. Remove scarified material and keep material free of contamination.

4. Replacing: Before replacing salvaged material, prepare subgrade as shown on the plans. Proof roll in accordance with Subsection 4.31 "Proof Rolling," when shown on the plans. Correct soft spots as directed.

Return and rework salvaged base material, with or without additional new base, on the prepared roadbed. Deposit salvaged material on the prepared subgrade and sprinkle, blade, and shape the base to conform to typical sections shown on the plans. When shown on the plans, place new base material and uniformly mix with salvaged material. Correct, or remove and replace, segregated material with satisfactory material as directed.

5. Stockpiling: Store salvage base material at a location shown on the plans. Prepare stockpile sites by removing and disposing of trash, wood, stumps, vegetation, and other objectionable materials as directed. Deliver salvaged material and construct stockpiles as directed.

6. Reshaping: Rework scarified base material with or without additional new base material, mix and shape scarified base to conform to the typical sections shown on the plans. When shown on the plans, furnish new base material, and uniformly mix with scarified material before shaping. Do not disturb the underlying subgrade. Correct, or remove and replace, segregated material with satisfactory material as directed.

7. Refinishing: Blade existing base surface to remove irregularities.

D. Compaction: Compact using density control. 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 Subsection 4.32, "Sprinkling. Begin rolling longitudinally at the sides and proceed towards the center, overlapping on successive trips by at least 1/2 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. Continue work until specification requirements are met. Perform the work at no additional expense to the City.

Before acceptance of the base, the ODR will select the locations of tests and measure the flexible base depth in accordance with Tex-140-E. Correct areas deficient by

more than ½ inch in thickness by scarifying, adding material as required, reshaping, recompacting, and refinishing at the Contractor's expense.

1. Ordinary Compaction: 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 100% of the maximum density of the proctor determined by Tex-113-E. Maintain moisture during compaction within +/- 2 percentage points of the optimum moisture content as determined by Tex-113-E. Measure the moisture content of the material in accordance with Tex-103-E during compaction daily and report the results the same day to the ODR. Do not achieve density by drying the material after compaction. The ODR or Engineer will determine roadway density and moisture content of completed sections in accordance with Tex-115-E. The ODR 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..

E. Finishing: After completing compaction, clip, skin, or tight-blade the surface with a maintainer or subgrade trimmer to grade. 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. Correct grade deviations greater than 1/4 inch in 16 feet measured longitudinally or greater than 1/4 inch over the entire width of the cross-section in areas where surfacing is to be placed. Correct by loosening, adding, or removing material. Reshape and recompact in accordance with Section 4.07.IV.C, "Compaction." Finished base will be swept with a Power Broom or other acceptable means at the discretion of the ODR if deemed necessary before subsequent courses are applied

F. Curing: Cure the finished section until the moisture content is at least 2 percentage points below optimum or as directed before applying the next successive course or prime coat.

V. Measurement. Work and accepted material as prescribed for flexible base will be measurement will be by a unit of square yards of surface area of the flexible base, in place, for a specified thickness and shall be measured from toe of gutter to toe of gutter or dimensions shown on the plans.

VI. Payment. The work performed and materials furnished in accordance with this subsection and measured as provided under "Measurement" will be paid for at the unit price bid for the types of work shown below. All types of working base will be paid by the square yard. No additional payment will be made for thickness or width exceeding that shown on the typical section or provided on the plans for cubic yard in the final position or square yard measurement. Sprinkling and rolling, will not be paid for directly but will be subsidiary to this Subsection. When proof rolling is shown on the plans or directed, it will be paid for in accordance with Subsection 4.26, "Proof Rolling."Where subgrade is constructed under this Contract, correction of soft spots in the subgrade will be at the Contractor's expense. Where subgrade is not constructed under this contract, correction of soft spots in the subgrade will be paid in accordance with pertinent Subsections of by Article 10.1.1, "Change Orders" in the Uniform General Conditions for City of Amarillo Civil Construction Contracts. 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, measuring, and equipment, labor, tools, and incidentals.

LAST PAGE OF SUBSECTION

Subsection 4.08
Concrete

I. Scope: This subsection includes materials for Portland cement concrete.

II. Materials

A. **General:** Unless otherwise specified on the plans, materials shall conform to the requirements of this Subsection.

The cement shall be Type II Portland cement. Type III cement shall be used when high-early strength concrete is required by the plans or special provisions. The Contractor shall obtain written permission of the Engineer, and shall assume all additional costs incurred by his use of another type of cement. Cement shall conform to DMS-4600 "Hydraulic Cement. When Type III cement is used, the average strength of briquettes at the age of 7 days shall be higher than that attained at 3 days. Either the tensile or the compressive tests may be used for either type cement.

Any cement storage shall be a suitable weather-tight building or bin which will protect the cement from dampness, and cement shall be so placed as to provide easy access for proper inspection and identification of each shipment.

Concrete will be the strength shown in Table 1 for the usage shown. Usages not shown will be determined as shown on the plans or determined by the Engineer or ODR. Other admixtures or blends may be used with the approval of the Engineer.

Table 1
Concrete Classes

Design Strength	Max. w/cm Ratio	Coarse Aggregate Grades	Cement Types	General Usage
3000 psi	0.60	1-6	II, III[1]	Curb, gutter, curb & gutter, sidewalks, non-reinforced drilled shafts, thrust block, riprap, wing walls, headwalls
4000 psi	0.45	2-5	II, III[1 2]	Paving[2], driveways, valleys, spandrels, aprons, inlets, manholes, direct traffic culverts

[1] Type III must be approved for use.
[2] See Subsection 4.14 for Concrete Paving

B. Cement Types: Portland cement shall conform to Types II, III in ASTM C 150 "Portland Cement."

C. Admixtures: Unless otherwise provided in the plans or special requirements, approved types of admixtures to minimize segregation, to improve workability, or to reduce the amount of mixing water may be used in the rate of dosage specified by the Engineer. Admixtures shall not be used to replace cement. The following types of

admixtures are generally used:

1. Air-Entraining Admixtures: Air-entraining admixtures shall conform to DMS-4640 "Chemical Admixtures for Concrete." An air entraining agent shall be used in all concrete. The air entraining agent shall be between 3% and 7% of air, by volume, of the concrete as discharged by the mixer.

2. Chemical Admixtures: Accelerating, retarding, and water-reducing admixtures, if used, shall conform to DMS-4640 "Chemical Admixtures for Concrete." Calcium chloride, if used, shall not exceed 2% percent by weight of the cement**.**

3. Pozzolanic Admixtures: Fly ash and other pozzolans, when used as an admixture shall conform to DMS-4610 "Fly Ash."

D. Coarse Aggregate: Coarse aggregate shall consist of durable particles of gravel, or crushed stone of reasonably uniform quality throughout, free from injurious amounts of salt, alkali, vegetable matter or other objectionable material, either free or as an adherent coating on the aggregate. Aggregate will meet the requirements of Table 2.

Table 2
Coarse Aggregate Requirements

Description	Test Method	Limit
Weight of Clay Lumps, % Max	Tex-413-A	0.25
Weight of Shale, % Max		1.0
Weight of Laminate and Friable Particle, % Max		5.0
L.A. Abrasion Wear, %Max	Tex-410-A	40
5-Cycle Magnesium Sulfate Soundness, % Max	Tex-411-A	18
Loss by Decantation, % Max	Tex-406-A	1.5

Provide coarse aggregate that conforms to the gradation requirements shown in Table 3 when tested in accordance with Tex-401-A.

Table 3
Coarse Aggregate Gradation Chart

Aggregate Grade No.	Nominal Size	Percent Retained on Each Sieve								
		2-1/2 Inch	2 Inch	1-1/2 Inch	1 Inch	3/4 Inch	1/2 Inch	3/8 Inch	No. 4	No. 8
1	2 1/2	0	0-20	15-50		60-80			95-100	
2 (467)*	1 1/2		0	0-5		30-65		70-90	95-100	
3	1		0	0-5		10-40	40-75		95-100	
4 (57)*	1			0	0-5		40-75		90-100	95-100
5 (67)*	3/4				0	0-10		45-80	90-100	95-100
6 (7)*	1/2					0	0-10	30-60	85-100	
7	3/8						0	5-30	75-100	
8	No. 4						0	0-5	35-60	90-100

*Numbers in parenthesis indicate that these gradations conform to corresponding ASTM gradation from ASTM C 33. The number ranges are the percentages retained on individual sieves.

All aggregates shall be handled and stored in such a manner as to prevent size segregation and contamination by foreign substances. When segregation is apparent, the aggregate shall be re-mixed. At the time of its use, the aggregate shall be free from frozen material and aggregate containing foreign materials will be rejected. Coarse aggregate that contains more than 0.5 percent free moisture by weight shall be stockpiled for at least 24 hours prior to use.

E. Fine Aggregate: Fine aggregate shall consist of sand or a combination of sands, and shall be composed of clean, hard, durable, uncoated grains.

1. Fine Aggregate Exclusive of Mineral Filler: Fine aggregate shall be free from injurious amounts of salt, alkali, or vegetable matter. Provide fine aggregate meeting Table 4.

Table 4
Fine Aggregate Requirements

Description	Test Method	Limit
Weight of Clay Clumps, % Max	Tex-413-A	0.5
Organic Impurities	Tex-408-A	Lighter than standard
Sand Equivalent	Tex-203-F	80
Fineness Modulus	Tex-402-A	2.3 to 3.1

When the fine aggregate is mixed with Type III cement in the proportion of 1:3, the average strength of not less than 3 standard mortar briquettes at the age of 3 days shall be equal to or greater than the strength of Ottawa sand mortar briquettes of the same proportions and consistency when tested at the age of 3 days.

Fine aggregate when tested in accordance with Tex-401-A shall meet the following gradation shown in Table 5.

Table 5
Fine Aggregate Gradation Chart (Grade 1)

Sieve Size	Percent passing
3/8"	100
#4	95-100
#8	80-100
#16	50-85
#30	25-65
#50	10-35[1]
#100	0-10
#200	0-3[2]

[1]6-35 when sand equivalent is greater than 85.
[2]0-6 for manufactured sand.

Where fine aggregate is delivered to the job in two or more sizes or types, each type and or size of material shall be batched and weighed separately.

At the time of its use, the fine aggregate shall be free from frozen material, and aggregate containing foreign material will be rejected.

All fine aggregate shall be stockpiled for at least 24 hours prior to use.

2. Mineral Filler: Mineral filler shall consist of clean stone dust, crushed sand, crushed shell, or other approved inert material. When tested in accordance with TxDOT's Bulletin C-11, it shall meet the requirements of Table 6.

Table 6
Gradation for Mineral Filler

Sieve Size	Percent Retained
#30	0%
#200	0 to 35%

Where mineral filler is used, it shall be batched and weighed separately.

F. Water: Water usage shall conform to Subsection 3.04 "Requirements for Water Usage."

G. Concrete Mortar: Mortar shall consist of 1 part cement, 2 parts finely graded sand and sufficient water to make the mixture plastic.

III. Equipment

A. Concrete Plants: All plants must be certified by the National Ready Mixed Concrete Association (NRMCA) or have an inspection report signed and sealed by a Texas licensed professional engineer showing concrete measuring, mixing, and delivery equipment meets all requirements of ASTM C94. A new certification or signed and sealed report is required every time a plant is moved. Plants with a inspection report signed by a licensed professional engineer's will require re-inspection every 2 years. Provide a copy of the certification or signed and sealed inspection report to the ODR.

Inspect concrete trucks and furnish inspection reports on the condition of blades and fins and their percent wear from the original manufacturer's design for truck agitators

annually and fins are free of concrete buildup. Concrete trucks must be capable of combining the ingredients of the concrete into a thoroughly mixed and uniform mass and capable of discharging the concrete so at least 5 of the 6 requirements of Tex-472-A are met.

B. Scales. Provide a scale certification every 6 months in compliance with ASTM C94.

IV. Acceptance of Concrete: The Contractor will test the fresh and hardened concrete for acceptance. The results will be reported to the ODR. Investigate the quality of the materials, the concrete production operations, and other possible problem areas to determine cause for any concrete that fails to meet the required strengths. Concrete failing strength requirements will be evaluated by the ODR to determine if the concrete will be accepted or required to be removed and replaced. The Contractor will make and test 7 day and 28 day concrete cylinders. Acceptance will be on strengths required in Table 7.

Table 7
Concrete Testing Frequency

Test For	Test Number	Sampling Location	Frequency of Testing	Remarks
Compressive Strength	Tex-418-A	At point of placement	4 cylinders for each 60 CY or fraction thereof for 4000 psi concrete 4 cylinders for each 100 CY or fraction thereof for 3000 psi concrete.	Sampling shall be in accordance with Tex-407-A. 2 cylinders shall be tested at 7 days and if the average is below the design strength as defined in Table 1 of this Subsection, the remaining 2 cylinders shall be tested at 28 days. If the average value of the 2 cylinders broken at 7 days meets the design strength, the 2 remaining cylinders are not required to be tested.
Slump	Tex-415-A	At point of placement	When cylinders are taken.	Maximum slump will be 4 inches..
Entrained Air	Tex-416-A or Tex-414-A	At point of placement	When cylinders are taken.	A minimum of 3% and a maximum of 7% entrained air is required.
Temperature	Tex-422-A	At point of placement	When cylinders are taken.	Maximum concrete temperature shall be 90 ˚F.

In general, the consistency of the concrete mixture shall be such that:

1. The mortar will cling to the coarse aggregate;

2. The concrete is not sufficiently fluid to segregate when transported to the place of deposit;

3. The concrete, when dropped directly from the discharge chute of the mixer, will flatten out at the center of the pile; but the edges of the pile will stand up and not flow;

4. The mortar will show no free water when removed from the mixer;

5. The concrete will settle into place when deposited in the forms when transported in metal chutes at an angle of 30° with the horizontal, it will slide and will not flow into place; and

6. The surface of the finished concrete will be free from laitance or a surface film of free water.

Shrinkage Crack Control: Concrete shall be below the allowable temperature as determined by the Contractor by using (ACI 305 chart modified). The rate of evaporation of water from the concrete shall not exceed 0.15pounds per square foot per hour. The Contractor shall keep a log of air temperatures, relative humidity, wind velocity, and allowable concrete temperature for each day he places concrete. The log shall be readily available for review by the Project Representative. For air temperature, relative humidity and wind speeds other than what is listed, the next highest temperature shown, next lowest relative humidity, and next highest wind velocity interval shall be used to determine acceptable concrete temperature.

Contractor is to inform the concrete supplier of the temperature requirements prior to delivery to the project. The concrete temperature limit shall not be exceeded at least until fifteen minutes after surface finishing. Appropriate curing methods shall be used to prevent shrinkage cracks in conjunction with these concrete temperature requirements.

Concrete shall not be poured when wind or weather conditions are such that dirt, sand, or debris enters the concrete. No concrete will be placed when wind speeds exceed 25 miles per hour. The concrete shall be protected to maintain temperatures of not less than 50°F for 5 days after placement. If aggregate and water are heated, they shall not be heated above 175°F. Concrete shall not be placed when ambient temperature is less than 40°F. It shall be the responsibility of the Contractor to anticipate as nearly as possible changes in weather conditions which would affect the placement and protection of the concrete and to be prepared to protect freshly placed concrete when sudden changes in the weather make such protection necessary.

V. Construction

A. Trial batches: Perform preliminary and final trial batches when previous

satisfactory field data is not available. Test at least one set of 7 day cylinders and one set of 28 cylinders to verify that minimum strength is achieved.

B. Mixing and delivering concrete

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

2. When water is added, do not exceed the approved water-cement ratio. Mix concrete 30 revolutions after adding water. Do not add water after discharge of concrete has begun.

3. Each load of concrete shall have a batch ticket showing material used.

VI. 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.

LAST PAGE OF THIS SUBSECTION

Subsection 4.09
Concrete Separate Curb, Curb and Gutter

I. Scope: This subsection includes Portland cement concrete separate curb, curb and gutter constructed on an approved subgrade, flexible base, or other foundation. The construction shall conform to the lines and grades established on the plans. The project drawings shall provide details of all concrete work**.**

II. Materials

A. General: Unless otherwise specified on the plans, materials shall conform to the requirements as specified in this Subsection and Subsection 4.08, "Concrete."

B. Water: Water usage shall conform to Subsection 3.04, "Requirements for Water Usage."

C. Concrete Mortar: Mortar shall consist of 1 part cement, 2 parts finely graded sand and sufficient water to make the mixture plastic.

D. Curing Materials:

1. Burlap: Burlap shall be made from jute or hemp and, at the time of using shall be in good condition, free from holes, dirt, clay, or any other substance which interferes with its absorptive quality. It shall not contain any substance which would have a detrimental effect on the concrete. Burlap shall be of such quality that it will absorb water readily when dipped or sprayed and shall weigh not less than 7 ounces per square yard when clean and dry. Burlap made into mats may be used if care in handling is exercised to avoid marring the finished surface of the concrete.

2. Cotton Mats: Cotton mats for curing concrete shall conform to the requirements of AASHTO M 73 "Cotton Mats for Curing Concrete."

3. Waterproof Paper: Paper and impermeable sheets for curing concrete shall conform to the requirements of ASTM C 171 "Sheet Materials for Curing Concrete."

4. Liquid Membrane-Forming Compounds: Liquid membrane-forming compounds shall conform to the requirements of DMS-4650 "Hydraulic Cement Concrete Curing Materials and Evaporation Retardants."

E. Steel Reinforcement

1. Bars, Tie Bars, Dowels and Sleeves: All bars shall conform to Subsection 4.13 "Reinforcing Steel." Joint hook bolts may be used as an alternative to tie bars.

Such bolts shall not be less than 1/2 inch in diameter and should be equipped with threaded couplings. Dowel bars shall not be burred, roughened, or deformed out of round in such a manner as to affect slippage in the concrete. When metal sleeves are used, they shall cover the ends of the dowels for not less than 2 inches nor more than 3 inches. The sleeve shall be closed at one end and shall have a suitable stop to hold the end of the bar at least 1 inch from the closed end of the sleeve. It shall be of such rigid design that the closed end will not collapse during construction.

2. Supports: Chairs for holding tie rods, bars, and other structural members in correct position while the concrete is being placed shall be made of material approved by the Engineer prior to use.

F. Fiber Reinforcement: When allowed on the plans, the following types of fibers can be used:

1. Types:

a) Stainless, alloy, or carbon steel;

b) Alkali resistant glass; and

c) Synthetic.

2. Compliance: All fiber reinforcement shall conform to DMS-4550 “Fibers for Concrete.”

G. Expansion Joint Material: Preformed fiber expansion joint material shall be of the dimensions shown on the plans. The material may be the following types unless specifically noted otherwise on the plans. Preformed bituminous fiber material shall conform to ASTM D 1751 "Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Non-extruding and resilient bituminous types)." Preformed non-bituminous fiber material shall conform to ASTM D 1752 "Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction."

III. Equipment: The contractor shall provide all equipment required for this subsection, including equipment outlined in Subsection 4.08, “Concrete.”

IV. Construction Methods: The Contractor shall design, produce, transport, and place the class of concrete in accordance with requirements of this Subsection. The Contractor will perform quality assurance (QA) testing at the scope and frequency outlined in Table 1. QA testing conducted by the Contractor will be submitted to the ODR for review to determine payment and make acceptance decisions. The Contractor may perform quality control (Q/C) testing. The Contractor is allowed to submit Q/C testing to the ODR. The ODR reserves the right to take additional Q/A tests.

Table 1
Concrete Testing Frequency

Test For	Test Number	Sampling Location	Frequency of Testing	Remarks
Compressive Strength	Tex-418-A	At point of placement	4 cylinders for each 100 CY or fraction thereof for 3000 psi concrete.	Sampling shall be in accordance with Tex-407-A. 2 cylinders shall be tested at 7 days and if the average is below the design strength as defined in Table 1 of Subsection 4.08 "Concrete", the remaining 2 cylinders shall be tested at 28 days. If the average value of the 2 cylinders broken at 7 days meets the design strength the 2 remaining cylinders are not required to be tested.
Slump	Tex-415-A	At point of placement	When cylinders are taken.	Formed curb slump shall be 4 inches maximum, slip form curb shall be 1-1/2 inches maximum
Entrained Air	Tex-416A or Tex-414A	At point of placement	When cylinders are taken.	A minimum of 3% and a maximum of 7 % entrained is required.
Temperature	Tex-422-A	At point of placement	When cylinders are taken.	Maximum temperature at placement is 90˚F.

A. Subgrade Preparation: Subgrade shall be excavated and shaped to line, grade, and cross section. If dry, the subgrade shall be sprinkled lightly immediately before concrete placement.

The subgrade shall be excavated to the correct elevation. Any fill required shall be furnished by the Contractor and approved by the Project Representative. The subgrade in fill areas shall be brought to correct elevation by placing like soil or flexible base in layers not to exceed 4 inches in depth. Each layer shall be brought to ± 2% of optimum moisture and compacted to a density of 95% of Standard Proctor in the upper 6 inches of subgrade as outlined in 4.02, "Earthwork." In alleys the Contractor shall excavate around and take precautions to protect all existing improvements. Any damage to an existing improvement caused by the Contractor shall be repaired at the Contractor's expense..

Excavated material from alley apron construction shall be removed within 24 hours after subgrade preparation.

B. Forming: Forms shall be of wood or metal, of a satisfactory section, straight, free from warp, and of a depth equal to the thickness of the finished work. They shall be securely staked to line and grade and maintained in a true position during concrete placement. Inside forms for the curb shall be of approved material and shall be of such design as to provide the curb required and shall be rigidly attached to the outside forms. Face forms on curb radii may be omitted if a true section and an accurate flow line can be obtained by other methods.

Forms shall remain in place at least 12 hours after placement of concrete. Forms shall be

treated with light oil before each use and forms which are to be re-used shall be cleaned immediately after use and maintained in good condition.

Stakes used shall be channel or U-shaped metal, 3/4 inches wide, 3/8 inches deep, and not less than 16 gauge (Manufacturers' standard gauge for steel sheets) in thickness. They shall be a minimum of 15 inches in length or longer in necessary to provide proper bearing support. Wooden stakes capable of maintaining forms in place during concrete placement are acceptable.

C. Reinforcing: The reinforcing steel bars and/or dowels shall be of the correct size and dimension and shall be placed and secured in position as shown on the plans.

D. Concrete: Concrete shall be satisfactorily mixed, placed in the forms to the depth specified, spaded, and tamped until thoroughly compacted. The top surface shall be finished with a wooden float to a gritty texture.

Should a chute be used in placing concrete, the slope of the chute and the delivery end of the chute shall be such that the concrete will flow without separation. The delivery end of the chute shall be as close as possible to the point of deposit. The chute shall be thoroughly flushed with water before and after each run. The flushing shall discharge outside the forms.

All concrete surfaces shall be reasonably true and even, free from pockets, depressions or projections, and given a steel trowel finish and then a light brush finish.

An edging tool with a radius of approximately 1/4 inch shall be used along the top back edge of the curb, along the front edge of the gutter, and along each side of each expansion joint.

All concrete shall be properly cured by being kept moist for 3 days with wetted burlap or mats, or by an approved process. Concrete may be cured by applying a liquid membrane coating (curing compound) to all exposed surfaces.

The curb and gutter shall be backfilled to the full height of the concrete, tamped and sloped as directed.

Concrete shall be deposited that requires minimum rehandling and obtain a uniformly dense section, free of honeycombs, and conforming to line, grade, and cross section.

In general, the consistency of the concrete mixture shall be such that:

1. The mortar will cling to the coarse aggregate;

2. The concrete is not sufficiently fluid to segregate when transported to the place of deposit;

3. The concrete, when dropped directly from the discharge chute of the mixer, will flatten out at the center of the pile; but the edges of the pile will stand up and

not flow;

4. The mortar will show no free water when removed from the mixer;

5. The concrete will settle into place when deposited in the forms when transported in metal chutes at an angle of 30° with the horizontal, it will slide and will not flow into place; and

6. The surface of the finished concrete will be free from laitance or a surface film of free water.

Shrinkage Crack Control: Concrete shall be below the allowable temperature as determined by the Contractor by using (ACI 305 chart modified). The rate of evaporation of water from the concrete shall not exceed 0.15pounds per square foot per hour. For air temperature, relative humidity and wind speeds other than what is listed, the next highest temperature shown, next lowest relative humidity, and next highest wind velocity interval shall be used to determine acceptable concrete temperature.

Contractor is to inform the concrete supplier of the temperature requirements prior to delivery to the project. The concrete temperature limit shall not be exceeded at least until fifteen minutes after surface finishing. Appropriate curing methods shall be used to prevent shrinkage cracks in conjunction with these concrete temperature requirements.

Concrete shall not be poured when wind or weather conditions are such that dirt, sand, or debris enters the concrete. No concrete will be placed when wind speeds exceed 25 miles per hour. The concrete shall be protected to maintain temperatures of not less than 50°F for 5 days after placement. If aggregate and water are heated, they shall not be heated above 175°F. Concrete shall not be placed when ambient temperature is less than 40°F. It shall be the responsibility of the Contractor to anticipate as nearly as possible changes in weather conditions which would affect the placement and protection of the concrete and to be prepared to protect freshly placed concrete when sudden changes in the weather make such protection necessary.

E. Expansion Joints and Scoring: Expansion joints shall be placed at intervals not to exceed 30 feet in the curb and gutter and at such other locations as may be shown on the plans. Expansion joints shall be placed vertically and at right angles to the longitudinal axis of the curb and gutter. An expansion joint shall be placed at the end of each radius where the radius connects onto concrete curb and gutter. Forethought shall be used in the spacing of expansion joints and also in the spacing of the scoring so as to have approximately equal spacings and so that no short or long spacings will exist.

Where curb and gutter is being constructed adjacent to or abutting existing concrete construction, an expansion joint shall be placed between the new and the existing concrete. Expansion material shall also be placed around all obstructions protruding through sidewalks or driveways.

All expansion joints shall be pre-molded expansion joint monolithic with that of the gutter portion of the curb and gutter and shall be cut true to shape so that the edge of the

expansion joint will be approximately 1/4 inch below the face and the top of the curb. Those expansion joints in sidewalk shall be placed in the same manner.

Scoring shall be placed in curb and gutters by the use of approved jointing tools, the spacing of the scoring shall be10 feet or less.

F. Horizontal and Vertical Control: All forms for concrete work shall be inspected and checked by the Project Representative to insure their compliance with established lines and grades before any concrete is poured. The Contractor shall notify the appropriate department at least four hours prior to pouring of any concrete to have forms checked. No concrete is to be poured until the Project Representative accepts the forms, foundation conditions, amount, size, and location of reinforcement.

G. Protection: The Contractor shall provide and maintain all necessary barricades and sufficient lights, signals, signs, watchmen, and any and all other things necessary for the protection of the work and for the safety of the public.

The Contractor must protect his work against weather, vandals, and any and all things that may mar the finish, surface, or the appearance of the concrete. Any damage to the surface is cause for rejection of all concrete between the expansion joints on either side of the damaged surface.

V. Measurement: Concrete separate curb and concrete curb and gutter will be measured by the linear foot, complete in place.

VI. Payment: The work performed and materials furnished as prescribed by this subsection and measured as provided will be paid for at the unit price bid. The prices shall be full compensation for preparing the subgrade; for furnishing, and placing all materials, including all reinforcement and expansion joint materials; for furnishing, placing, testing, shaping and tamping backfill; and for all manipulation, labor, tools, equipment, and incidentals necessary to complete the work.

LAST PAGE OF THIS SUBSECTION

Subsection 4.10
Miscellaneous Concrete

I. Scope: This subsection includes Portland cement concrete for but not limited to sidewalks, medians, and islands, with or without reinforcing steel as required, constructed on an approved subgrade, sand, flexible base, or other foundation. The construction shall conform to the lines and grades established on the plans. The project drawings shall provide details of all concrete work.

II. Materials

A. Concrete: Concrete shall conform to the requirements of Subsection 4.08 "Concrete." Concrete shall meet 3000 psi.

B. Water: Water usage shall conform to Subsection 3.04 "Requirements for Water Usage."

C. Concrete Mortar: Mortar shall consist of 1 part cement, 2 parts finely graded sand and sufficient water to make the mixture plastic.

D. Curing Materials:

1. Burlap: Burlap shall be made from jute or hemp and, at the time of using shall be in good condition, free from holes, dirt, clay, or any other substance which interferes with its absorptive quality. It shall not contain any substance which would have a detrimental effect on the concrete. Burlap shall be of such quality that it will absorb water readily when dipped or sprayed and shall weigh not less than 7 ounces per square yard when clean and dry. Burlap made into mats may be used if care in handling is exercised to avoid marring the finished surface of the concrete.

2. Cotton Mats: Cotton mats for curing concrete shall conform to the requirements of AASHTO M 73 "Cotton Mats for Curing Concrete."

3. Waterproof Paper: Paper and impermeable sheets for curing concrete shall conform to the requirements of ASTM C 171 "Sheet Materials for Curing Concrete."

4. Liquid Membrane-Forming Compounds: Liquid membrane-forming compounds shall conform to the requirements of DMS-4650 "Hydraulic Cement Concrete Curing Materials and Evaporation Retardants."

E. Steel Reinforcement

1. Welded Wire Fabric: Welded wire fabric shall conform to the

requirements of Subsection 4.13, "Reinforcing Steel."

2. Bars, Tie Bars, Dowels and Sleeves: All bars shall conform to Subsection 4.13 "Reinforcing Steel." Joint hook bolts may be used as an alternative to tie bars. Such bolts shall not be less than 1/2 inch in diameter and should be equipped with threaded couplings. Dowel bars shall not be burred, roughened, or deformed out of round in such a manner as to affect slippage in the concrete. When metal sleeves are used, they shall cover the ends of the dowels for not less than 2 inches nor more than 3 inches. The sleeve shall be closed at one end and shall have a suitable stop to hold the end of the bar at least 1 inch from the closed end of the sleeve. It shall be of such rigid design that the closed end will not collapse during construction.

3. Supports: Chairs for holding tie rods, bars, and other structural members in correct position while the concrete is being placed shall be made of material approved by the Engineer prior to use.

F. Fiber Reinforcement: When allowed on the plans the following types will be allowed:

1. Types:

a) Stainless, alloy, or carbon steel;

b) Alkali resistant glass; and

c) Synthetic fiber.

2. Compliance: All fiber reinforcement shall conform to DMS-4550 "Fibers for Concrete."

G. Expansion Joint Material: Preformed fiber expansion joint material shall be of the dimensions shown on the plans. The material may be the following types unless specifically noted otherwise on the plans. Preformed bituminous fiber material shall conform to ASTM D 1751 "Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Non-extruding and resilient bituminous types)." Preformed non-bituminous fiber material shall conform to ASTM D 1752 "Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction."

H. Joint Sealing Material: Unless otherwise shown on the plans, joint sealing material shall conform to the requirements of Subsection 4.29 "Crack and Joint Sealing."

III. Equipment: Contractor shall all equipment including those covered in Subsection 4.08 "Concrete."

IV. Construction Methods: The Contractor shall design, produce, transport, and place the strength of concrete in accordance with requirements of this subsection. The Contractor will perform quality assurance (QA) testing at the scope and frequency outlined in Table 1. QA testing conducted by the Contractor will be submitted to the ODR for review to determine

payment and make acceptance decisions. The Contractor may perform quality control (Q/C) testing. The Contractor is allowed to submit Q/C testing to the ODR. The ODR reserves the right to take additional Q/A tests.

Table 1
Concrete Testing Frequency

Test For	Test Number	Sampling Location	Frequency of Testing	Remarks
Compressive Strength	Tex-418-A	At point of placement	4 cylinders for each 100 CY or fraction thereof for 3000 psi concrete.	Sampling shall be in accordance with Tex-407-A. 2 cylinders shall be tested at 7 days and if the average is below the design strength as defined in Table 1 of Subsection 4.08 "Concrete", the remaining 2 cylinders shall be tested at 28 days. If the average value of the 2 cylinders broken at 7 days meet design strength the 2 remaining cylinders are not required to be tested.
Slump	Tex-415-A	At point of placement	When cylinders are taken.	Slump shall be 4" maximum.
Entrained Air	Tex-416-A or Tex-414-A	At point of placement	When cylinders are taken.	A minimum of 3% and a maximum of 7% entrained air is required.
Temperature	Tex-422-A	At point of placement	When cylinders are taken.	Maximum temperature at placement is 90°F.

A. Subgrade Preparation: Subgrade shall be excavated and shaped to line, grade, and cross section. If dry, the subgrade shall be sprinkled lightly immediately before concrete placement.

The subgrade shall be excavated to the correct elevation. Any fill required shall be furnished by the Contractor and approved by the Project Representative. The subgrade in fill areas shall be brought to correct elevation by placing like soil or flexible base in layers not to exceed 4 inches in depth. Each layer shall be brought to ± 2% of optimum moisture and compacted to a density of 95% of Standard Proctor in the upper 6 inches of subgrade. Any damage to an existing improvement caused by the Contractor shall be repaired.

B. Forming: Forms shall be of wood or metal, of a satisfactory section, straight, free from warp, and of a depth equal to the thickness of the finished work. They shall be securely staked to line and grade and maintained in a true position during concrete placement.

Stakes used to support expansion joint fillers shall be channel or U-shaped metal, 3/4 inches wide, 3/8 inches deep, and not less than 16 gauge (Manufacturers' standard gauge for steel sheets) in thickness. They shall be a minimum of 15 inches in length or longer in necessary to provide proper bearing support. Wooden stakes sufficient to hold forms in place are also acceptable.

Forms shall remain in place at least 12 hours after placement of concrete. Forms shall be treated with light oil before each use and forms which are to be re-used shall be cleaned

immediately after use and maintained in good condition.

C. Reinforcing: The reinforcing steel bars and/or dowels shall be of the correct size and dimension and shall be placed and secured in position as shown on the plans.

Where welded wire mesh reinforcement is specified, the mesh shall lap not less than 7 inches and shall be securely tied. All wire mesh shall be neatly cut to the shape of the construction and to fit around all obstructions. Reinforcing bars at proper spacing may be substituted for welded wire mesh. No reinforcing steel shall be placed within 3 inches of forms.

D. Concrete: Concrete shall be satisfactorily mixed, placed in the forms to the depth specified, spaded, and tamped until thoroughly compacted. The top surface shall be finished with a wooden float to a gritty texture.

Should a chute be used in placing concrete, the slope of the chute and the delivery end of the chute shall be such that the concrete will flow without separation. The delivery end of the chute shall be as close as possible to the point of deposit. The chute shall be thoroughly flushed with water before and after each run. The flushing shall discharge outside the forms.

All concrete surfaces shall be reasonably true and even, free from pockets, depressions or projections, and given a steel trowel finish and then a light brush finish.

An edging tool with a radius of approximately 1/4 inch shall be used along each edge of a sidewalk and along each side of each expansion joint.

Concrete shall be deposited that requires minimum rehandling and obtain a uniformly dense section, free of honeycombs, and conforming to line, grade, and cross section.

In general, the consistency of the concrete mixture shall be such that:

1. The mortar will cling to the coarse aggregate;

2. The concrete is not sufficiently fluid to segregate when transported to the place of deposit;

3. The concrete, when dropped directly from the discharge chute of the mixer, will flatten out at the center of the pile; but the edges of the pile will stand up and not flow;

4. The mortar will show no free water when removed from the mixer;

5. The concrete will settle into place when deposited in the forms when transported in metal chutes at an angle of 30° with the horizontal, it will slide and will not flow into place; and

6. The surface of the finished concrete will be free from laitance or a surface

film of free water,

Shrinkage Crack Control: Concrete shall be below the allowable temperature as determined by the Contractor by using (ACI 305 chart modified). The rate of evaporation of water from the concrete shall not exceed 0.15pounds per square foot per hour. For air temperature, relative humidity and wind speeds other than what is listed, the next highest temperature shown, next lowest relative humidity, and next highest wind velocity interval shall be used to determine acceptable concrete temperature.

Contractor is to inform the concrete supplier of the temperature requirements prior to delivery to the project. The concrete temperature limit shall not be exceeded at least until fifteen minutes after surface finishing. Appropriate curing methods shall be used to prevent shrinkage cracks in conjunction with these concrete temperature requirements.

Concrete shall not be poured when wind or weather conditions are such that dirt, sand, or debris enters the concrete. No concrete will be placed when wind speeds exceed 25 miles per hour. The concrete shall be protected to maintain temperatures of not less than 50°F for 5 days after placement. If aggregate and water are heated, they shall not be heated above 175°F. Concrete shall not be placed when ambient temperature is less than 40°F. It shall be the responsibility of the Contractor to anticipate as nearly as possible changes in weather conditions which would affect the placement and protection of the concrete and to be prepared to protect freshly placed concrete when sudden changes in the weather make such protection necessary.

E. Sidewalks: All sidewalks shall have a maximum transverse slope of 2%. Care shall be exercised to match the grade of sidewalk to the top of curb (where applicable) and to the grade of driveways, if any. Care shall also be taken to ramp sidewalk to tie flush with alley paving.

All sidewalks constructed at a location designated on the plans shall not be less than 4 feet in width. All ADA requirements will be met.

F. Medians and Islands: Place concrete for each section to the lines, grades, and cross sections. Separate sections from adjacent curbs or adjoining sections using expansion or contraction joints of the type and size shown on the plans. A curb section may be used for the perimeter of the median or island when shown on the plans. Construct curbs in accordance with Subsection 4.09 "Concrete Curb, and Curb and Gutter." Finish exposed surfaces with a wood or metal float after sufficient concrete set. Round edges as shown on the plans. Cure at least 72 hours.

G. Steps: All steps shall have a tread of not less than 12 inches and a riser of not more than 7 inches. Where more than one step is constructed at a location, the treads and risers for each shall be of equal dimension.

H. Expansion Joints and Scoring: Expansion joints shall be placed at intervals not to exceed 30 feet in the sidewalk. For medians and islands, expansion joints will be shown on the plans. An expansion joint shall be placed at the end of each radius where the radius connects onto concrete curb and gutter. Forethought shall be used in the spacing of expansion joints and also in the spacing of the scoring so as to have

approximately equal spacings and so that no short or long spacings will exist. Scoring shall be placed by the use of approved jointing tools. Scoring on sidewalks shall be at 5 foot spacing in each direction. All expansion joints shall be ¼ inch below surface of the concrete.

Where a sidewalk is being constructed adjacent to or abutting existing concrete construction, an expansion joint shall be placed between the new and the existing concrete. Expansion material shall also be placed around all obstructions protruding through sidewalks.

I. Curing: All concrete shall be properly cured by being kept moist for 3 days with wetted burlap or mats, or by an approved process. Concrete may be cured by applying a liquid membrane coating (curing compound) to all exposed surfaces.

J. Horizontal and Vertical Control: All forms for concrete work shall be inspected and checked by the Project Representative to insure their compliance with established lines and grades before any concrete is poured. The Contractor shall notify the appropriate department at least four hours prior to pouring of any concrete to have forms checked. No concrete is to be poured until the Project Representative accepts the forms, foundation conditions, amount, size, and location of reinforcement.

K. Protection: The Contractor shall provide and maintain all necessary barricades and sufficient lights, signals, signs, watchmen, and any and all other things necessary for the protection of the work and for the safety of the public.

The Contractor must protect his work against weather, vandals, and any and all things that may mar the finish, surface, or the appearance of the concrete. Any damage to the surface is cause for rejection of all concrete between the expansion joints on either side of the damaged surface.

V. Measurement: Work and accepted material as prescribed for sidewalks, islands, medians or similar concrete construction will be measured by a unit shown in the plans and installed.

VI. Payment: The work performed and materials furnished as prescribed by this subsection and measured as provided will be paid for at the unit price bid. The prices shall each be full compensation for preparing the subgrade; for furnishing, and placing all materials, including all reinforcement and expansion joint materials; for furnishing, placing, testing, shaping and tamping backfill; and for all manipulation, labor, tools, equipment, and incidentals necessary to complete the work.

LAST PAGE OF THIS SUBSECTION

Subsection 4.11
Structural Concrete

I. Scope: This item includes Portland cement for but not limited to driveways, valleys, alley aprons, and spandrels, constructed on an approved subgrade, sand, flexible base, or other foundation. The construction shall conform to the lines and grades established on the plans. The project drawings shall provide details of all concrete work.

II. Materials

A. Concrete: Concrete shall conform to the requirements of Subsection 4.08, "Concrete." Concrete shall meet 4000 psi.

B. Water: Water usage shall conform to Subsection 3.04, "Requirements for Water Usage."

C. Concrete Mortar: Mortar shall consist of 1 part cement, 2 parts finely graded sand and sufficient water to make the mixture plastic.

D. Curing Materials:

1. Burlap: Burlap shall be made from jute or hemp and, at the time of using shall be in good condition, free from holes, dirt, clay, or any other substance which interferes with its absorptive quality. It shall not contain any substance which would have a deleterious effect on the concrete. Burlap shall be of such quality that it will absorb water readily when dipped or sprayed and shall weigh not less than 7 ounces per square yard when clean and dry. Burlap made into mats may be used if care in handling is exercised to avoid marring the finished surface of the concrete.

2. Cotton Mats: Cotton mats for curing concrete shall conform to the requirements of AASHTO M 73, "Cotton Mats for Curing Concrete."

3. Waterproof Paper: Paper and impermeable sheets for curing concrete shall conform to the requirements of ASTM C 171, "Sheet Materials for Curing Concrete."

4. Liquid Membrane-Forming Compounds: Liquid membrane-forming compounds shall conform to the requirements of DMS-4650, "Hydraulic Cement Concrete Curing Materials and Evaporation Retardants."

E. Steel Reinforcement

1. Bars, Tie Bars, Dowels and Sleeves: All bars shall conform to Subsection 4.13, "Reinforcing Steel." Joint hook bolts may be used as an alternative to tie bars.

Such bolts shall not be less than 1/2 inch in diameter and should be equipped with threaded couplings. Dowel bars shall not be burred, roughened, or deformed out of round in such a manner as to affect slippage in the concrete. When metal sleeves are used, they shall cover the ends of the dowels for not less than 2 inches nor more than 3 inches. The sleeve shall be closed at one end and shall have a suitable stop to hold the end of the bar at least 1 inch from the closed end of the sleeve. It shall be of such rigid design that the closed end will not collapse during construction.

2. Supports: Chairs for holding tie rods, bars, and other structural members in correct position while the concrete is being placed shall be made of material approved by the Engineer prior to use.

F. Expansion Joint Material: Preformed fiber expansion joint material shall be of the dimensions shown on the plans. The material may be the following types unless specifically noted otherwise on the plans. Preformed bituminous fiber material shall conform to ASTM D 1751, "Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Non-extruding and resilient bituminous types)." Preformed non-bituminous fiber material shall conform to ASTM D 1752, "Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction."

G. Joint Sealing Material: Unless otherwise shown on the plans, joint sealing material shall conform to the requirements of Subsection 4.29, “Crack and Joint Sealing.”

III. Equipment: Contractor shall all equipment including those covered in Subsection 4.08, “Concrete.”

IV. Construction Methods: The Contractor shall design, produce, transport, and place the class of concrete in accordance with requirements of this Subsection. The Contractor will perform quality assurance (QA) testing at the scope and frequency outlined in Table 1. QA testing conducted by the Contractor will be submitted to the ODR for review to determine payment and make acceptance decisions. The Contractor may perform quality control (Q/C) testing. The Contractor is allowed to submit Q/C testing to the ODR. The ODR reserves the right to take additional Q/A tests.

Table 1
Concrete Testing Frequency

Test For	Test Number	Sampling Location	Frequency of Testing	Remarks
Compressive Strength	Tex-418-A	At point of placement	4 cylinders for each 100 CY or fraction thereof for 4000 psi concrete.	Sampling shall be in accordance with Tex-407-A. 2 cylinders shall be tested at 7 days and if the average is below the design strength as defined in Table 1 of Subsection 4.08 "Concrete", the remaining 2 cylinders shall be tested at 28 days. If the average value of the 2 cylinders broken at 7 days the 2 remaining cylinders are not required to be tested.
Slump	Tex-415-A	At point of placement	When cylinders are taken.	Slump shall be 4" maximum.
Entrained Air	Tex-416-A or Tex-414-A	At point of placement	When cylinders are taken.	A minimum of 3% and a maximum of 7% entrained air is required.
Temperature	Tex-422-A	At point of placement	When cylinders are taken.	The maximum temperature at placement is 90˚F.

A. Subgrade Preparation: Subgrade shall be excavated and shaped to line, grade, and cross section. If dry, the subgrade shall be sprinkled lightly immediately before concrete placement.

The subgrade shall be excavated to the correct elevation. Any fill required shall be furnished by the Contractor and approved by the Project Representative. The subgrade in fill areas shall be brought to correct elevation by placing like soil or flexible base in layers not to exceed 4 inches in depth. Each layer shall be brought to ± 2% of optimum moisture and compacted to a density of 95% of Standard Proctor in the upper 6 inches of subgrade. Any damage to an existing improvement caused by the Contractor shall be repaired.

B. Forming: Forms shall be of wood or metal, of a satisfactory section, straight, free from warp, and of a depth equal to the thickness of the finished work. They shall be securely staked to line and grade and maintained in a true position during concrete placement.

Stakes used to support expansion joint fillers shall be channel or U-shaped metal, 3/4 inches wide, 3/8 inches deep, and not less than 16 gauge (Manufacturers' standard gauge for steel sheets) in thickness. They shall be a minimum of 15 inches in length or longer in necessary to provide proper bearing support.

Forms shall remain in place at least 12 hours after placement of concrete. Forms shall be treated with light oil before each use and forms which are to be re-used shall be cleaned immediately after use and maintained in good condition.

C. Reinforcing: The reinforcing steel bars and/or dowels shall be of the correct size and dimension and shall be placed and secured in position as shown on the plans.

D. Concrete: Concrete shall be satisfactorily mixed, placed in the forms to the depth specified, spaded, and tamped until thoroughly compacted. The top surface shall be finished with a wooden float to a gritty texture.

Should a chute be used in placing concrete, the slope of the chute and the delivery end of the chute shall be such that the concrete will flow without separation. The delivery end of the chute shall be as close as possible to the point of deposit. The chute shall be thoroughly flushed with water before and after each run. The flushing shall discharge outside the forms.

All concrete surfaces shall be reasonably true and even, free from pockets, depressions or projections, and given a steel trowel finish and then a light brush finish.

An edging tool with a radius of approximately 1/4 inch shall be used along each edge and along each side of each expansion joint.

All concrete shall be properly cured by being kept moist for 3 days with wetted burlap or mats, or by an approved process. Concrete may be cured by applying a liquid membrane coating (curing compound) to all exposed surfaces.

Concrete shall be deposited that requires minimum rehandling and obtain a uniformly dense section, free of honeycombs, and conforming to line, grade, and cross section.

In general, the consistency of the concrete mixture shall be such that:

1. The mortar will cling to the coarse aggregate;

2. The concrete is not sufficiently fluid to segregate when transported to the place of deposit;

3. The concrete, when dropped directly from the discharge chute of the mixer, will flatten out at the center of the pile; but the edges of the pile will stand up and not flow;

4. The mortar will show no free water when removed from the mixer;

5. The concrete will settle into place when deposited in the forms; and when transported in metal chutes at an angle of 30° with the horizontal, it will slide and will not flow into place;

6. The surface of the finished concrete will be free from laitance or a surface

film of free water; and

Shrinkage Crack Control: Concrete shall be below the allowable temperature as determined by the Contractor by using (ACI 305 chart modified). The rate of evaporation of water from the concrete shall not exceed 0.15pounds per square foot per hour. The Contractor shall keep a log of air temperatures, relative humidity, wind velocity, and allowable concrete temperature for each day he places concrete. The log shall be readily available for review by the Project Representative. For air temperature, relative humidity and wind speeds other than what is listed, the next highest temperature shown, next lowest relative humidity, and next highest wind velocity interval shall be used to determine acceptable concrete temperature.

Contractor is to inform the concrete supplier of the temperature requirements prior to delivery to the project. The concrete temperature limit shall not be exceeded at least until fifteen minutes after surface finishing. Appropriate curing methods shall be used to prevent shrinkage cracks in conjunction with these concrete temperature requirements.

Concrete shall not be poured when wind or weather conditions are such that dirt, sand, or debris enters the concrete. No concrete will be placed when wind speeds exceed 25 miles per hour. The concrete shall be protected to maintain temperatures of not less than 50°F for 5 days after placement. If aggregate and water are heated, they shall not be heated above 175°F. Concrete shall not be placed when ambient temperature is less than 40°F. It shall be the responsibility of the Contractor to anticipate as nearly as possible changes in weather conditions which would affect the placement and protection of the concrete and to be prepared to protect freshly placed concrete when sudden changes in the weather make such protection necessary.

E. Driveways and Alley Aprons: Driveways and Alley Aprons will have a maximum slope of 8%. Driveways shall be built to the dimensions shown in the plans.

F. Concrete Valleys: Shall be built as drawn on the plans

G. Expansion Joints and Scoring: Expansion joints shall be shown on the plans. An expansion joint shall be placed at the end of each radius where the radius connects onto concrete curb and gutter. Forethought shall be used in the spacing of expansion joints and also in the spacing of the scoring so as to have approximately equal spacings and so that no short or long spacings will exist.

Expansion material shall also be placed around all obstructions protruding through driveways.

All expansion joints shall be ¼ inch below surface of the concrete.

H. Horizontal and Vertical Control*:* All forms for concrete work shall be inspected and checked by the Project Representative to insure their compliance with established lines and grades before any concrete is poured. The Contractor shall notify the appropriate department at least four hours prior to pouring of any concrete to have forms checked. No concrete is to be poured until the Project Representative accepts the forms, foundation conditions, amount, size, and location of reinforcement.

I. Protection: The Contractor shall provide and maintain all necessary barricades and sufficient lights, signals, signs, watchmen, and any and all other things necessary for the protection of the work and for the safety of the public.

The Contractor must protect his work against weather, vandals, and any and all things that may mar the finish, surface, or the appearance of the concrete. Any damage to the surface is cause for rejection of all concrete between the expansion joints on either side of the damaged surface.

V. Measurement: Concrete for structural items will be measured by the square foot, complete in place.

VI. Payment: The work performed and materials furnished as prescribed by this item and measured as provided will be paid for at the unit price bid. The prices shall each be full compensation for preparing the subgrade; for furnishing, and placing all materials, including all reinforcement and expansion joint materials; for furnishing, placing, testing, shaping and tamping backfill; and for all manipulation, labor, tools, equipment, and incidentals necessary to complete the work.

LAST PAGE OF THIS SUBSECTION

Subsection 4.12
Riprap

I. Scope: Furnish and place concrete or stone riprap.

II. Materials

A. Concrete: Concrete shall conform to the requirements of Subsection 4.08, "Concrete." Concrete shall be 3000 psi.

B. Stone Riprap: The Contractor shall supply durable stone with a bulk specific gravity of at least 2.50 as determined by Tex-403-A, unless otherwise shown on the plans. Provide stone that, when tested in accordance with Tex-411-A, has a weight loss of no more than 18% after 5 cycles of magnesium sulfate solution.

Provide filter fabric in accordance with TxDOT's DMS-6200, "Filter Fabric." Provide Type 2 filter fabric unless otherwise shown on the plans.

Use stones between 50 and 250 pounds. Use stones that are at least 3 inches in their least dimension. Material may consist of broken concrete that meets the same requirements of virgin aggregate. Cut exposed steel reinforcement flush with all surfaces before placement.

III. Construction: Dress slopes to the lines and grades to the line and grade shown on the plans before placement of riprap. Place riprap and toe walls according to details and dimensions shown on the plans.

A. Concrete Riprap. Reinforce concrete riprap with 6 inch x 6 inch – W2.9 x W2.9 welded wire fabric or with No. 3 reinforcing bars meeting the requirements of Subsection 4.13, "Reinforcing Steel," spaced at a maximum of 18 inches in each direction unless otherwise shown. Provide a minimum splice of 6 inches. Bars can be no closer than 3 inches and no further than 6 inches to the forms and centered in the thickness of the riprap using chairs of other devices to hold bars in place. Weld wire fabric must be kept off the bottom during placement. When allowed fiber reinforcement can be used, the following fibers are acceptable:

a) Stainless, alloy, or carbon steel;

b) Alkali resistant glass; and

c) Synthetic.

Consolidate the subgrade and sprinkle surface before placement of concrete.

Compact and shape the concrete once it has been placed to conform to the dimensions shown on the plans. Finish the surface with a wood float after concrete has set

sufficiently to avoid slumping to secure a smooth surface and broom finish.

B. Curing Materials: Cure riprap immediately after finishing with one of the following applications.

a) Burlap: Burlap shall be made from jute or hemp and, at the time of using shall be in good condition, free from holes, dirt, clay, or any other substance which interferes with its absorptive quality. It shall not contain any substance which would have a detrimental effect on the concrete. Burlap shall be of such quality that it will absorb water readily when dipped or sprayed and shall weigh not less than 7 ounces per square yard when clean and dry. Burlap made into mats may be used if care in handling is exercised to avoid marring the finished surface of the concrete.

b) Cotton Mats: Cotton mats for curing concrete shall conform to the requirements of AASHTO M 73 "Cotton Mats for Curing Concrete."

c) Waterproof Paper: Paper and impermeable sheets for curing concrete shall conform to the requirements of ASTM C 171, "Sheet Materials for Curing Concrete."

d) Liquid Membrane-Forming Compounds: Liquid membrane-forming compounds shall conform to the requirements of ASTM C 309, "Liquid Membrane-Forming Compounds for Curing Concrete."

C. Expansion Joint Material: Preformed fiber expansion joint material shall be of the dimensions shown on the plans. The material may be the following types unless specifically noted otherwise on the plans. Preformed bituminous fiber material shall conform to ASTM D 1751, "Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Non-extruding and resilient bituminous types)." Preformed non-bituminous fiber material shall conform to ASTM D 1752, "Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction."

IV. Equipment: The contractor will supply all equipment including those in Subsection, 4.08, “Concrete.”

V. CONSTRUCTION METHODS: The Contractor shall design, produce, transport, and place the class of concrete in accordance with requirements of this Subsection. The Contractor will perform quality assurance (QA) testing at the scope and frequency outlined in Table 1. QA testing conducted by the Contractor will be submitted to the ODR for review to determine payment and make acceptance decisions. The Contractor may perform quality control (Q/C) testing. The Contractor is allowed to submit Q/C testing to the ODR. The ODR reserves the right to take additional Q/A tests.

Table 1
Concrete Testing Frequency

Test For	Test Number	Sampling Location	Frequency of Testing	Remarks
Compressive Strength	Tex-418-A	At point of placement	4 cylinders for each 100 CY or fraction thereof for 3000 psi concrete.	Sampling shall be in accordance with Tex-407-A. 2 cylinders shall be tested at 7 days and if the average is below the design strength as defined in Table 1 of Subsection 4.08 "Concrete", the remaining 2 cylinders shall be tested at 28 days. If the average value of the 2 cylinders broken at 7 days meets the design strength, the 2 remaining cylinders are not required to be tested.
Slump	Tex-415-A	At point of placement	When cylinders are taken.	Maximum slump allowed is 4%.
Entrained Air	Tex-416-A or Tex-414-A	At point of placement	When cylinders are taken.	A minimum of 3% and a maximum of 7% entrained air is required.
Temperature	Tex-422-A	At point of placement	When cylinders are taken.	Maximum of 90˚F at placement.

A. Forming: Forms shall be of wood or metal, of a satisfactory section, straight, free from warp, and of a depth equal to the thickness of the finished work. They shall be securely staked to line and grade and maintained in a true position during concrete placement.

Forms shall remain in place at least 12 hours after placement of concrete. Forms shall be treated with light oil before each use and forms which are to be re-used shall be cleaned immediately after use and maintained in good condition.

B. Shrinkage Crack Control: Concrete shall be below the allowable temperature as determined by the Contractor by using (ACI 305 chart (modified). The rate of evaporation of water from the concrete shall not exceed 0.15pounds per square foot per hour. For air temperature, relative humidity and wind speeds other than what is listed, the next highest temperature shown, next lowest relative humidity, and next highest wind velocity interval shall be used to determine acceptable concrete temperature.

Contractor is to inform the concrete supplier of the temperature requirements prior to delivery to the project. The concrete temperature limit shall not be exceeded at least until fifteen minutes after surface finishing. Appropriate curing methods shall be used to prevent shrinkage cracks in conjunction with these concrete temperature requirements.

Concrete shall not be poured when wind or weather conditions are such that dirt, sand, or debris enters the concrete. No concrete will be placed when wind speeds exceed 25 miles per hour. The concrete shall be protected to maintain temperatures of not less than 50°F for 5 days after placement. If aggregate and water are heated, they shall not be heated above 175°F. Concrete shall not be placed when ambient temperature is less than 40°F. It shall be the responsibility of the Contractor to anticipate as nearly as possible changes in weather conditions which would affect the placement and protection of the concrete and to be prepared to protect freshly placed concrete when sudden changes in the weather make

such protection necessary.

C. Expansion Joints and Scoring: Expansion joints shall be placed at intervals not to exceed 30 feet and at such other locations as may be shown on the plans. Expansion joints shall be placed vertically Forethought shall be used in the spacing of expansion joints and also in the spacing of the scoring so as to have approximately equal spacings and so that no short or long spacings will exist.

Where a sidewalk or curb and gutter are being constructed adjacent to or abutting existing concrete construction, an expansion joint shall be placed between the new and the existing concrete. Expansion material shall also be placed around all obstructions protruding through the riprap.

All expansion joints shall be premoulded expansion joint monolithic with the edge of the expansion joint will be approximately 1/4 inch below the face of finished surface

D. Protection: The Contractor must protect his work against weather, vandals, and any and all things that may mar the finish, surface, or the appearance of the concrete. Any damage to the surface is cause for rejection of all concrete between the expansion joints on either side of the damaged surface.

VI. Measurement: Riprap will be measured by the square yard, complete in place.

VII. PAYMENT

The work performed and materials furnished as prescribed by this item and measured as provided will be paid for at the unit price bid. The prices shall each be full compensation for preparing the subgrade; for furnishing, and placing all materials, including all reinforcement and expansion joint materials; for furnishing, placing, testing, shaping and tamping backfill; and for all manipulation, labor, tools, equipment, and incidentals necessary to complete the work.

LAST PAGE OF THIS SUBSECTION

Subsection 4.13
Reinforcing Steel

I. Scope: This item includes the furnishing and placing of reinforcing steel, deformed and smooth, of the size and quantity designated and in accordance with these specifications and with plan details.

II. Materials

A. Unless otherwise designated on the plans, or herein, all bar reinforcement shall be deformed, and shall conform to 1 of the following:

1. ASTM A 615, Grade 60, open hearth, basic oxygen, or electric furnace new billet steel, or ASTM 617, Grade 60, axle-steel;

2. Where bending or bar sizes No. 14 or No. 18 of Grade 60 is required, bend testing shall be performed on representative specimens as described for smaller bars in the applicable ASTM Specification. The required bend shall be 90° around a pin having a diameter of 10 times the nominal diameter of the bar.

3. Spiral reinforcement shall be either smooth or deformed bars, or wire, of the minimum size or gage shown on the plans. Bars for spiral reinforcement shall comply with ASTM A 675, A 615 or A 617. Wire shall comply with ASTM A 82.

4. Unless otherwise shown on the plans the minimum yield strength for spiral reinforcement shall be 40,000 pounds per square inch.

5. Report of chemical analysis, showing the percentages of carbon, manganese, phosphorus and sulfur will be required for all reinforcing steel.

6. Smooth bars, larger than No. 4, may be furnished in any steel that meets the physical requirements of ASTM A36.

7. Smooth round bars shall be designated by size number through No. 4. Smooth bars above No. 4 shall be designated by diameter inches.

8. Wire fabric reinforcement shall be cold-drawn from rods hot-rolled from open hearth, basic oxygen, or electric furnace billeted. Wire shall conform to the requirements of the Standard Specifications for Cold-Drawn St. eel Wire for Concrete Reinforcement, ASTM A82 or A496. Wire fabric, when used as reinforcement, shall conform to ASTM A185 or A497.

B. Bending: The reinforcement shall be bent cold, true to the shapes indicated on the plans. Bending shall preferably be done in the shop. Irregularities in bending shall be cause for rejection. Unless otherwise shown in the plans, inside

diameter of bar bends, in terms of the nominal bar diameter (d), must be as shown in Table 1.

Table 1
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, 26	8d
	14, 18	43, 57	10d

C. Tolerances: Fabricating tolerances for bars, from plan dimensions, shall not be greater than ASTM requirements.

D. Storing: Steel reinforcement shall be stored above the surface of the ground upon platforms, skids, or other supports and shall be protected as far as practicable from mechanical injury and surface deterioration caused by exposure to conditions producing rust. When placed in the work, reinforcement shall be free from dirt, paint, grease, oil, or other foreign materials. Reinforcement shall be free from injurious defects such as cracks and laminations. Rust, surface seams, surface irregularities or mill scale will not be cause for rejection, provided the minimum dimensions, cross sectional area and tensile properties of a hand wire brushed specimen meets the physical requirements for the size and grade of steel specified.

E. Splices: No splicing bars, except when provided on the plans, or, specified herein, will be permitted without written approval of the Engineer.

Splices not provided for on the plans will be permitted in slabs not more than 15 inches in thickness, columns, walls and parapets, but not included for measurement, subject to the following:

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 shall not be less than 30 feet minus splice length, with no more than 1 individual bar length less than 10 feet. Splices not shown on the plans, but permitted hereby, shall be made in accordance with Table 2. The specified concrete cover shall be maintained at such splices and the bars placed in contact and securely tied together.

Table 2
Minimum Lap Length

Bar Size Number (in.)	Bar Size Number (mm)	Uncoated Lap Length	Coated Lap Length	Weight per foot
3	10	1'-0"	2'-0"	0.376
4	13	1'-9"	2'-8"	0.668
5	16	2'-2"	3'-3"	1.043
6	19	2'-7"	3'-11"	1.502
7	22	3'-5"	5'-2"	2.044
8	25	4'-6"	6'-9"	2.670
9	29	5'-8"	8'-6"	3.400
10	32	7'-3"	10'-11"	4.303
11	36	8'-11"	13'-5"	5.313

Spiral steel shall be lapped a minimum of 1 turn. Sizes No. 14 and No. 18 may not be lapped.

Welding of reinforcing bars may be done only where shown on the plans or as permitted herein. All welding operations, process, equipment, materials, workmanship, and inspection shall conform to the requirements of the plans. All splices shall be of such dimension and character as to develop the full strength of the bar being spliced.

End preparation for butt welding reinforcing bars, shall be done in the field. Delivered bars shall be of sufficient length to permit this practice.

F. Welded Wire Fabric: For wire reinforcement, use wire that conforms to ASTM A185 or A497. Observe the relations shown in Table 3 among size number, diameter in inches, and area ordering wire by size numbers. Letters that precede the size number are "D" for deformed wire and "W" for smooth wire.

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

Table 3
Wire Size Number, Diameter, and Area

Wire Size Number English	Wire Size Number Metric	Diameter (in.)	Area (sq. in.)
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

G. Epoxy Coating: Epoxy coating will be required when shown in the plans. Coat reinforcing steel in accordance with Table 4. Patch damaged epoxy coating with approved material. Maintain identification of all reinforcement 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 the Subsection and 1 copy of the manufacturer's control tests.

Table 4
Epoxy Coating Requirements for Reinforcing Steel

Material	Specification
Bar	ASTM A 775 or A 934
Wire	ASTM A 884 Class A or B

H. Mechanical Couplers: When mechanical splices in reinforcing steel bars are shown on the plans, use the following types of coupler:

1. Sleeve filler;

2. Sleeve threaded;

3. Sleeve swaged; or

4. Sleeve wedge.

I. Placing: Unless otherwise shown on the plans, dimensions shown for reinforcement are to the centers of the bars. Reinforcement shall be placed as near as possible in the position shown on the plans. In the plane of the steel parallel to the nearest surface of concrete, bars shall not vary from the 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 shall not vary from plan placement by more than ¼ of the spacing between bars. Clear cover of concrete to the nearest surface of steel shall meet the above requirements but shall never be less than 2 inches.

The reinforcement shall be accurately located in the forms, and firmly held in place, before and during concrete placement, by means of bar supports, adequate in strength and number to prevent displacement, to keep the steel at the proper distance from the forms and to carry the reinforcing bars they support. Bars shall be supported by standard galvanized bar supports, bar supports with plastic tips, stainless steel bar supports, approved plastic bar supports or approved pre-cast mortar or concrete blocks,

Mortar or concrete blocks shall be cast to uniform dimensions with adequate bearing area. A suitable tie wire shall be provided in each block for anchoring to the steel. They shall be accurately cast to the thickness required in molds approved by the Engineer. The surface placed adjacent to the form shall be a true plane, free of surface imperfections. The blocks shall be cured by covering with wet burlap or mats for a period of 72 hours. Mortar for blocks shall contain approximately 1 part cement to 3 parts sand. Concrete for blocks shall contain 9 sacks of cement per cubic yards.

Individual bar supports shall be placed in rows at 4 foot maximum spacing in each direction. Continuous type bar supports shall be placed at 4 feet maximum spacing.

Reinforcing steel for top slabs of culverts and the top slabs shall be tied at all intersections except that where the spacing is less than 1 foot in each direction, alternate intersections only need to be tied. For reinforcing steel cages for other structural members, the steel shall be tied at enough intersections to provide a rigid cage of steel. Mats of wire fabric shall overlap each other 1 full space as a minimum to maintain a uniform strength and shall be fastened securely at the ends and edges.

Before any concrete is placed, all mortar, mud, dirt, etc. shall be cleaned from the reinforcement. No concrete shall be deposited until the Project Representative approves reinforcing steel placement.

If the reinforcement is not adequately supported or tied to resist settlement, floating upward, overturning of truss bars, or movement in any direction during concrete placement, permission to continue concrete placement will be withheld until corrective measures are taken. Sufficient measurements shall be made during concrete placement to insure compliance.

III. 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 Subsections.

LAST PAGE OF THIS SUBSECTION

Subsection 4.14
Concrete Pavement

I. Scope: Construct hydraulic cement concrete pavement with or without curbs on the concrete pavement.

II. Materials

A. General: Provide hydraulic cement concrete in accordance with Subsection 4.08, "Concrete," concrete shall be 4000 psi.

B. Steel Reinforcement: Provide deformed steel for bar reinforcement in accordance with Subsection 4.13, "Reinforcing Steel."

1. Reinforcing Steel: Provide grade 60 or above, deformed steel for bar reinforcement in accordance with Subsection 4.13, "Reinforcing Steel."

2. Dowels. Provide smooth straight dowels of the size shown on the plans, free of burrs and conforming to Subsection 4.13, "Reinforcing Steel." Coat dowels with a thin film of grease, wax, silicone or other approved de-bonding material. Provide dowels 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.

3. Tie Bars: Provide straight deformed steel tie bars. Provide either multiple-piece tie bars or single-piece tie bars as shown on the plans. Furnish multiple piece tie bars in accordance with Subsection 4.13, "Reinforcing Steel."

4. Supports: Chairs for holding tie rods, bars, and other structural members in correct position while the concrete is being placed shall be made of material approved by the Engineer prior to use.

C. Curing Materials: Provide Type 2 membrane curing compound conforming to DMS-4650, Hydraulic Cement Curing Materials and Evaporation Retardants." Provide insulating blankets for curing fast track concrete pavement with a minimum thermal resistance (R) rating of 0.5 hour-square foot F/BTU. Use insulating blankets that are free from tears and are in good condition.

D. Epoxy: Provide Type III, Class C epoxy in accordance with DMS-6100, "Epoxies and Adhesives," for installing all drilled-in reinforcing steel. Submit a work plan and request approval for the use of epoxy types other than Type III, Class C.

E. Evaporation Retardant: Provide evaporation retardant conforming to DMS-4650, Hydraulic Cement Curing Materials and Evaporation Retardants."

F. Joint Sealants and Fillers: Provide Class 5 or Class 8 joint sealant materials and

fillers unless otherwise shown in the plans in accordance with DMS-6310, "Joint Sealants and Fillers."

G. Water: Water usage shall conform to Subsection 3.04 "Requirements for Water Usage."

III. Equipment

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Furnish and maintain all equipment in good condition. Use measuring, mixing, delivery equipment conforming to the requirements of Subsection 4.08 "Concrete."

A. Forming Equipment: Provide metal forms of sufficient cross-section, strength, and rigidity to resist bowing or failure during placement. Provide 3 stakes per 10 foot form. 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 less than 100-foot radius or less. Inside forms for the curb shall be of approved material and shall be of such design as to provide the curb required and shall be rigidly attached to the outside forms. Face forms on curb radii may be omitted if a true section and an accurate flow line can be obtained by other methods.

B. Placing, Consolidating, and Finishing Equipment: Provide approved equipment that uniformly distributes the concrete with minimal segregation and provides consolidated concrete pavement with a smooth finish conforming to lines and grade. Provide approved finishing floats capable of producing a uniformly smooth pavement. Provide equipment that is capable of applying a fine, light water fog mist. Provide vibrators capable of adequately consolidating the concrete over the entire width and depth of the pavement and in accordance with the manufacturer's recommendations

C. Texturing Equipment

1. Carpet Drag: Provide a carpet drag mounted on a work bridge or a manual 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.

2. Tining Equipment: Provide tined equipment with steel tines with a cross-section approximately 1/32 inch thick x 1/12 inch wide. Tine spacing will be approximately 1 inch, center to center apart.

3. Curing Equipment: Provide a device for applying curing compound using mechanically pressurized spraying equipment with atomizing nozzles. Equipment must be able to maintain the required uniform rate of application over the entire paving area.

4. Sawing Equipment: Provide power driven concrete saws to saw joints

shown on the plans.

IV. Construction Methods: The Contractor shall design, produce, transport, and place the class of concrete in accordance with requirements of this Subsection. The Contractor will perform quality assurance (QA) testing at the scope and frequency outlined in Table 1. QA testing conducted by the Contractor will be submitted to the ODR for review to determine payment and make acceptance decisions. The Contractor may perform quality control (Q/C) testing. The Contractor is allowed to submit Q/C testing to the ODR. The ODR reserves the right to take additional Q/A tests.

Table 1
Concrete Testing Frequency

Test For	Test Number	Sampling Location	Frequency of Testing	Remarks
Compressive Strength	Tex-418-A	At point of placement	4 cylinders for each 1500 SY or fraction thereof	Sampling shall be in accordance with Tex-407-A. 2 cylinders shall be tested at 7 days and if the average is below the design strength as defined in Table 1 of Subsection 4.08 "Concrete", the remaining 2 cylinders shall be tested at 28 days. If the average value of the 2 cylinders broken at 7 days and meets the design strength the 2 remaining cylinders are not required to be tested.
Slump	Tex-415-A	At point of placement	When cylinders are taken.	Formed paving maximum slump is 4 inches. Slip form paving maximum slump is 1 inch.
Entrained Air	Tex-416A or Tex-414-A	At point of placement	When cylinders are taken.	Entrained air requirement is a minimum of 3% to maximum of 7%
Temperature	Tex-422-A	At point of placement	When cylinders are taken.	Concrete temperature of 90°F maximum is allowed.

A. Subgrade Preparation: Subgrade shall be excavated and shaped to line, grade, and cross section. If dry, the subgrade shall be sprinkled lightly immediately before concrete placement.

The subgrade shall be excavated to the correct elevation. Any fill required shall be furnished by the Contractor and approved by the Project Representative. The subgrade in fill areas shall be brought to correct elevation by placing like soil or flexible base in layers not to exceed 4 inches in depth. Each layer shall be brought to ± 2% of optimum moisture and compacted to a density of 95% of Standard Proctor in the upper 6 inches of subgrade as detailed in Subsection 4.02, "Earthwork." In alleys the Contractor shall excavate around and take precautions to protect all existing improvements. All obstructions and improvements that must remain where concrete pavement is placed shall be wrapped with 2 layers of 15 pound roofing felt to the level of the top surface of the slab. Any damage to an existing improvement caused by the Contractor shall be repaired.

B. Forming: Forms shall remain in place at least 12 hours after placement of concrete. Forms shall be oiled with light oil before each use and forms which are to be re-used shall be cleaned immediately after use and maintained in good condition.

C. Reinforcing: The reinforcing steel bars and/or dowels shall be of the correct size and dimension and shall be placed and secured in position as shown on the plans.

D. Concrete: Concrete shall be satisfactorily mixed, placed in the forms to the depth specified, spaded, and tamped until thoroughly compacted. The top surface shall be finished with a bull float.

Should a chute be used in placing concrete, the slope of the chute and the delivery end of the chute shall be such that the concrete will flow without separation. The delivery end of the chute shall be as close as possible to the point of deposit. The chute shall be thoroughly flushed with water before and after each run. The flushing shall discharge outside the forms.

All concrete surfaces shall be reasonably true and even, free from pockets, depressions or projections, before carpet drag.

All concrete shall be properly cured by being kept moist for 3 days with wetted burlap or mats, or by an approved process. Concrete may be cured by applying a liquid membrane coating (curing compound) to all exposed surfaces.

Concrete shall be deposited that requires minimum rehandling and obtain a uniformly dense section, free of honeycombs, and conforming to line, grade, and cross section.

In general, the consistency of the concrete mixture shall be such that:

1. The mortar will cling to the coarse aggregate;

2. The concrete is not sufficiently fluid to segregate when transported to the place of deposit;

3. The concrete, when dropped directly from the discharge chute of the mixer, will flatten out at the center of the pile; but the edges of the pile will stand up and

not flow;

4. The mortar will show no free water when removed from the mixer;

5. The concrete will settle into place when deposited in the forms when transported in metal chutes at an angle of 30° with the horizontal, it will slide and will not flow into place; and

6. The surface of the finished concrete will be free from laitance or a surface film of free water;

Shrinkage Crack Control: Concrete shall be below the allowable temperature as determined by the Contractor by using ACI 305 chart (modified). The rate of evaporation of water from the concrete shall not exceed 0.15 pounds per square foot per hour. For air temperature, relative humidity and wind speeds other than what is listed, the next highest temperature shown, next lowest relative humidity, and next highest wind velocity interval shall be used to determine acceptable concrete temperature.

Contractor is to inform the concrete supplier of the temperature requirements prior to delivery to the project. The concrete temperature limit shall not be exceeded at least until fifteen minutes after surface finishing. Appropriate curing methods shall be used to prevent shrinkage cracks in conjunction with these concrete temperature requirements.

Concrete shall not be poured when wind or weather conditions are such that dirt, sand, or debris enters the concrete. No concrete will be placed when wind speeds exceed 25 miles per hour. The concrete shall be protected to maintain temperatures of not less than 50°F for 5 days after placement. If aggregate and water are heated, they shall not be heated above 175°F. Concrete shall not be placed when ambient temperature is less than 40°F. It shall be the responsibility of the Contractor to anticipate as nearly as possible changes in weather conditions which would affect the placement and protection of the concrete and to be prepared to protect freshly placed concrete when sudden changes in the weather make such protection necessary.

E. Texturing: Complete final texturing before the concrete has attained initial set. Drag the carpet longitudinally along the pavement surface with the carpet contact surface adjusted to provide a satisfactory coarsely textured surface. Prevent the carpet from getting plugged with grout. Do not perform carpet drag operations while there is excessive bleed water.

A metal-tine finish is required unless otherwise shown on the plans. Provide transverse tining unless otherwise shown on the plans. Immediately following the carpet drag, apply a single coat of evaporation retardant, if needed, at the rate recommended by the manufacturer. Provide the metal-tine finish immediately after the concrete surface has set enough for consistent tining. The metal-tine device shall obtain grooves 3/16 inch deep ± 1/8 inch and approximately 1/12 inch wide. Do not overlap previously tined area.

F. Curing: Keep the concrete pavement surface from drying until the curing compound has been applied. Spray the concrete surface uniformly with 2 coats of

membrane curing at an individual application rate of no more 180 square feet per gallon. Manage finishing and texturing operations to ensure placement of curing compound on a moist concrete surface, relatively free of bleed water, to prevent any plastic shrinkage cracking.

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

Maintain and properly repair damage to curing materials on exposed surfaces of concrete continuously for at least 3 days. A curing day is defined as a 24 hour period when either the temperature of the concrete is maintained at 40˚F or above.

G. Sawing: 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, 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. Promptly restore membrane curing damaged by sawing.

H. Horizontal and Vertical Control*:* All forms for concrete work shall be inspected and checked by the Project Representative to insure their compliance with established lines and grades before any concrete is poured. The Contractor shall notify the appropriate department at least four hours prior to pouring of any concrete to have forms checked. No concrete is to be poured until the Project Representative accepts the forms, foundation conditions, amount, size, and location of reinforcement.

The ODR will check thickness, pavement that has deficiencies greater than 0.25 inches will be subject to removal.

I. Protection: The Contractor shall provide and maintain all necessary barricades and sufficient lights, signals, signs, watchmen, and any and all other things necessary for the protection of the work and for the safety of the public.

The Contractor must protect his work against weather, vandals, and any and all things that may mar the finish, surface, or the appearance of the concrete. Any damage to the surface is cause for rejection of all concrete between the expansion joints on either side of the damaged surface.

Testing for early opening is the responsibility of the Contractor. Results will be submitted to the ODR for approval.

J. Backfill and Repair of Damaged Concrete in Alley Pavement*:* The area between the alley slab and the property line shall be filled and or shaped as required to obtain the specified cross section and to provide a smooth, even slope from the edge of the alley slab to the property line. Backfill between the alley slab and the property line shall be compacted to a density at least that of the adjacent undisturbed soil. No blading will be permitted on the concrete alley pavement.

Only damage of a very minor nature shall be repaired by approved patching. Any substantial damage to the concrete alley pavement is cause for rejection of that section of pavement between expansion joints on either side of the damaged area, and the damage shall be repaired at the Contractor's expense to the satisfaction of the Engineer.

V. Measurement: Concrete pavement will be measured by the square yard of concrete paving depth shown on the plans.

VI. Payment: The work performed and materials furnished as prescribed by this subsection and measured as provided will be paid for at the unit price bid. The prices shall each be full compensation for preparing the subgrade; for furnishing and placing all materials, including all reinforcement and expansion joint materials; for furnishing, placing, shaping and tamping backfill; and for all manipulation, labor, tools, equipment, and incidentals necessary to complete the work**.**

LAST PAGE OF THIS SUBSECTION

Subsection 4.15
Planing and Texturing Pavement

I. Scope: This subsection includes planing and texturing existing asphaltic concrete pavement, asphalt-stabilized base, or concrete pavement for the depths indicated on the plans and stockpiling of the scarified materials at the designated locations.

II. Materials

A. Water: Water usage shall conform to Subsection 3.04, "Requirements for Water Usage."

III. Equipment

A. Planing Machine. Use a planing machine that:

1. Have a minimum 6 foot cutting width except for areas less than 6 foot wide;

2. Is self-propelled with enough power, traction, and stability to maintain an accurate depth of cut and slope;

3. Can cut one continuous operation: 4 inches of asphalt concrete pavement, 1 inch of concrete pavement, or a combination of 2 inches of asphalt concrete pavement and ½ inch of concrete pavement;

4. Use dual longitudinal controls capable of operating on both sides automatically from any longitudinal grade reference, which includes string line, ski, mobile string line, or matching shoe;

5. Use transverse controls with an automatic system to control cross slope at any given rate;

6. Use integral loading and reclaiming devices to allow cutting, removal, and discharge of the material into a truck in one operation;

7. Includes devices to control dust created by the cutting action; and

8. Use a manual system providing for uniformly varying the depth of cut while the machine is in motion thereby making it possible to cut flush to all inlets, manholes, or other obstructions within the paved area.

B. Sweeper. Use street sweeper to remove cuttings and debris from the planed or textured pavement unless otherwise directed. Equip the sweeper with a water tank, dust control spray assembly, both a pick-up and a gutter broom, and a debris

hopper.

C. Stockpiling Equipment. Provide trucks to haul cuttings to designated stockpile site when shown on the plans. Provide a loader to stockpile material as directed.

IV. Construction Methods

The pavement surface shall be removed to the depth, width, grade and cross section as required.

The pavement planing operation shall be referenced from an independent grade control in areas deemed appropriate by the Engineer. For this operation, the independent grade control shall be established and maintained by the Contractor in an acceptable manner and the final position of same shall be acceptable to the Engineer.

If the entire pavement width or traveled lane width along a section of street has not been planed to a flush surface by the end of a work period resulting in a vertical or near vertical longitudinal face exceeding 1-1/4 inches in height, this longitudinal face shall be sloped to not create a hazard to traffic. Transverse faces that are present at the end of a working period will be tapered to avoid creating a hazard for traffic.

The cuttings or loose material resulting from the planing operation shall remain the property of the City and the Contractor shall stockpile the material at designated locations. Salvaged material shall be kept as free as possible from contamination by non-asphaltic materials during its removal, transportation, and storage. Placement methods at stockpiles shall be approved by the Project Representative. Salvaged asphaltic paving materials of differing type or quality may require separate stockpiling.

When located within 4 inches of steep curbs, asphaltic concrete and/or asphalt-stabilized base that cannot be removed by the planing machine shall be removed by other acceptable methods and the pavement and curb surfaces shall be cleaned of all debris and left in a neat and presentable condition.

In planed areas where traffic is permitted, "Grooved Pavement Ahead" signs shall be erected at an appropriate distance ahead of the planed areas and at a maximum spacing of 1/2 mile within the planed area. Signs shall be erected prior to planing in the areas and shall be maintained in place until the planed area is overlaid. Signs shall be in accordance with the "Texas Manual on Uniform Traffic Control Devices for Streets and Highways" and "Standard Highway Sign Designs for Texas." After planed areas are overlaid, the Contractor shall remove these signs.

In areas where traffic is permitted, a texture shall be produced which shall be a grid pattern with uniform discontinuous longitudinal striations, or any other pattern with discontinuous longitudinal striations that provide a satisfactory riding surface. Planing machine shall travel at a speed that creates a consistent pattern.

Unless otherwise directed, the grade reference used by the Contractor may be of any approved type. Control points, when applicable, will be established for the finished grade by the

Engineer. These points will be set at intervals not to exceed 50 feet. The Contractor shall set the grade reference for the sensor of the automatic control to follow from the control points established by the Engineer. This grade reference shall have sufficient support so that the maximum deflection shall not exceed 1/16 inch per 25 feet.

The surface of the pavement after planing shall be smooth and true to the established line, grade and cross section. When tested with a 10 foot straightedge placed parallel to the centerline of the roadway or tested by other equivalent or acceptable means, the maximum deviation shall not exceed 1/8 inch in 10 feet. Any point in the surface not meeting this requirement shall be corrected.

V. Measurement

Work prescribed by this subsection will be measured by the square yard of surface area for the various depths shown on the plans or as described in the proposal. Measurement will be based on the depth shown for each bid item, within the limits shown on the plans, regardless of the actual thickness removed or the number of passes required. Only one bid item will be applicable to any one location. Square yard calculations will be based on the neat dimensions shown on the plans. Measurement will be made only one time for each depth regardless of the number of passes required to be made by the machine in order to secure the depth desired. Tapering or sloping of longitudinal or transverse joints (faces) as described under "Construction Methods" will not be measured for payment.

VI. Payment

The work performed as prescribed by this subsection, measured as provided under "Measurement" will be paid for at the unit price bid per square yard for "Planing and Texturing Pavement" of the various depths shown on the plans, which price shall be full compensation for removing all materials to the depth shown, loading, hauling, unloading, and satisfactorily stockpiling of the material and for all signs and sign removal, labor, tools, equipment, manipulation and incidentals to complete the work.

LAST PAGE OF THIS SUBSECTION

Subsection 4.16
Seal Coat

I. Scope: This subsection includes a wearing surface composed of one or more applications of asphalt, covered with a layer of aggregate constructed on a prepared base course or existing surface.

II. Material

A. Asphalt: Asphalt shall conform to requirements as specified in Subsection 4.23, "Asphalts, Oils, & Emulsions."

B. Aggregate: Furnish aggregate for seal coats in conformance to the type, grade, and Surface Aggregate Classification (SAC) shown on the plans.

The materials will be uncontaminated and of uniform quality throughout that meets the requirements shown on the plans and specifications. Notify the ODR of all proposed material sources and of changes to material sources.

Furnish aggregate of the type shown on the plans and listed in Table 1.

Table 1
Aggregate Types

Type	Material
B	Crushed gravel or crushed stone
E	Aggregates shown on the plans
L	Lightweight aggregate
PB	Precoated crushed gravel or crushed stone
PE	Precoated aggregates shown on the plans
PL	Precoated lightweight aggregate

Ensure the aggregate gradation meets the requirements in Table 2 for the specified grade shown.

Furnish aggregates that meet the requirements shown in Table 3, unless otherwise shown on the plans. Provide aggregates from sources listed in TxDOT's Bituminous Rated Source Quality Catalog (BRSQC). Aggregates not listed in the BRSQC will have to have testing submitted to the ODR for approval.

Aggregates used on the final surface will have to meet the SAC shown on the plans. This will only apply to aggregate place on travel lanes. SAC list can be found in the BRSQC and Aggregate Quality Monitoring Program (AQMP).

C. Precoating: Precoat aggregate uniformly and adequately with asphalt material to the satisfaction of the ODR. Meet Table 2

and Table 3 requirements before precoating. Furnish precoated aggregate that spreads uniformly using approved mechanical spreading equipment. Asphalt shall conform to the requirements of Subsection 4.23, "Asphalts, Oils, & Emulsion."

The ODR retains the right to select a target value for the desired percent by weight of residual asphalt coating on the aggregate. Furnish precoated aggregate that is within ±0.3% of the target value when tested in accordance with Tex-236-F. The ODR may require trial batches to assist in selecting the target value.

The ODR retains the right to remove precoat material from aggregate samples in accordance with Tex-236-F and test aggregate to verify compliance with Table 2 and Table 3 requirements.

Table 2
Aggregate Gradation Requirements (Cumulative % Retained)

Sieve Size	**Grade**					
	1	**2**	**3**		**4**	**5**
			Non-Lightweight	Lightweight		
1"	-	-	-	-	-	-
7/8"	0-2	0	-	-	-	-
3/4"	20-35	0-2	0	0	-	-
5/8"	85-100	20-40	0-5	0-2	0	-
1/2"	-	80-100	20-40	10-25	0-5	0
3/8"	95-100	95-100	80-100	60-80	20-40	0-5
1/4"	-	-	95-100	95-100	-	-
#4	-	-	-	-	95-100	50-80
#8	99-100	99-100	99-100	98-100	98-100	98-100

Table 3
Aggregate Requirements

Property	Test Method	Requirement	Remarks
Sampling	Tex-221-F	-	
SAC	AQMP	As shown on the plans	
Deleterious Material, %, Max	Tex-217-F, Part I	2.0	Not required for lightweight aggregate
Decantation, %, Max	Tex-406-A	1.5	
Flakiness Index, Max	Tex-224-F	17	
Gradation	Tex-@200-F, Part I	See Table 2	
L.A. Abrasion, %, Max	Tex-410-A	35	
Magnesium Sulfate Soundness, 5 Cycle, %, Max	Tex-411-A	25	
Coarse Aggregate Angularity, 2 Crushed Faces, %, Min	Tex-460-A, Part I	85	Only required on crushed gravel
Additional requirements for Lightweight Aggregate			
Dry Loose Unit Wt., lb./cf	Tex-404-A	35-60	
Pressure Slaking. %, Max	Tex-431-A	6.0	
Freeze-Thaw Loss, %, Max	Tex-432-A	10.0	
Water Absorption, 24 hr., %, Max	Tex-433-A	12.0	

III. Equipment

A. Distributor: Furnish a distributor that conforms to the requirements in Subsection 4.25, "Equipment for Asphalt Concrete Pavement."

B. Aggregate Distributor: Use a continuous-feed, self-propelled spreader to apply aggregate uniformly at the specified rate.

C. Rollers: Provide rollers in accordance with Subsection 4.27, "Rolling."

D. Broom: Furnish rotary, self-propelled broom.

E. Aggregate Haul Trucks: Use trucks with a uniform capacity to deliver aggregate. Provide ODR with documentation showing measurements and calculation in cubic yards.

IV. Construction Methods

A. Asphalt Application

Seal coat season is defined in Subsection 4.23, "Asphalts Oils and Emulsion", for hot asphalt unless approved by ODR. The Engineer will approve the binder grade and the air and surface temperatures for asphalt material for cold weather applications.

No application shall be placed when the air temperature is below 60°F, unless cold

weather asphalt is used. The temperature shall be taken in the shade and away from artificial heat. No asphalt shall be placed when general weather conditions are not suitable. Application of asphalt will cease when temperature is 50°F and falling for hot asphalt applications

Select an application temperature, as approved, in accordance with Subsection 4.23, "Asphalt, Oils, & Emulsions. Uniformly apply the asphalt material at the rate directed, within 15°F of the approved temperature, and not above the maximum allowable temperature.

Asphalt for the each course shall be applied uniformly on the clean surface free of dirt, dust, vegetation, debris, or other harmful material. The Contractor shall provide paper joints or approved material at the beginning and end of each shot. The asphalt shot width shall be covered with aggregate by one pass of an approved spreader of the type shown on the plans.

Stop application if it is not uniform due to streaking, ridging, puddling, or flowing off the roadway surface. Determine and correct the cause of nonuniform application. The ODR may require a test strip to determine if issues are corrected. If shot varies by more than 0.05 gallon per square yard a test strip may be required to show that causes have been corrected. Test strip shall not be applied on the roadway. Test strip will not be paid for.

B. Aggregate Placement: As soon as possible, apply aggregate uniformly at the rate directed without causing the rock to roll over.

C. Rolling: Start rolling operation on each shot as soon as aggregate is applied. Use sufficient rollers to cover the entire mat in one pass. Roll in staggered pattern. Unless otherwise directed, make a minimum of 5 passes, unless emulsion is used, make 3 passes. The course shall be rolled, if a second application of asphalt is shown in the plans, it shall be made in the manner specified for the first application. Rolling shall continue as necessary to imbed the aggregate.

D. Patching and Sweeping: Before opening to traffic, patch area where coverage is not complete. Once aggregate has sufficiently bonded sweep to remove excess rock before opening to traffic.

The asphalt and aggregate shall be applied at the approximate rates indicated on Table 4.

Table 4
Application Rates

Application	Gallons of Asphalt per Square Yard		Aggregate Cubic Yards to Square Yards	
	Min	Max	Min	Max
First	0.25	0.30	1:110	1:90
Second	0.35	0.40	1:150	1:125

The Contractor shall maintain the surface until accepted by the Engineer.

E. Aggregate Furnished by the City: When shown on the plans, the City will

furnish aggregate to the Contractor without cost. Stockpile locations will be shown on the plans.

F. Rock Land and Shot:

1. Definitions

a) A “rock land” is the area covered at the aggregate rate directed with 1 truckload of aggregate.

b) A “shot” is the area covered by 1 distributor load of asphalt material.

2. Setting Lengths: Calculate the lengths of both rock land and asphalt shot. Adjust shot length to be an even multiple of the rock land. Verify the distributor has enough asphalt material to complete the entire shot length. Mark shot length before applying asphalt. Contractor shall provide distributor straps and load tickets for rock.

V. Measurement

A. Asphalt shall be measured in gallons at the applied temperature**.**

B. Aggregate shall be measured by the cubic yard in vehicles at the point of delivery on the site.

C. The measurement for payment may be by the square yard of the surface on which the bituminous surface treatment is actually applied.

VI. Payment

The work performed and materials furnished as prescribed by this subsection and measured as provided under "Measurement" shall be paid for at the unit price bid for " Seal Coat", which price shall be full compensation for cleaning existing surface; for furnishing, freight involved, preparing, hauling, and placing materials and all incidentals necessary to complete the work.

LAST PAGE OF THIS SUBSECTION

Subsection 4.17
Dense-Graded Hot-Mix Asphalt

I. Scope: The Contractor will construct a pavement layer composed of a compacted, dense-graded mixture of aggregate and asphalt binder mixed hot in a mixing plant.

II. Material: The Contractor shall furnish uncontaminated materials of uniform quality that meet the requirements of the plans and specifications. The contractor will notify the ODR (Owner Designated Representative) of all material sources. Notify the ODR before changing any material source or formulation. When the Contractor makes a source or formulation change, contractor shall provide verification that the requirements of this subsection are met and the ODR, or Engineer may require a new laboratory mixture design, trial batch, or both. The ODR or Engineer may perform sampling and testing of project materials at any time during the project to verify compliance.

A. Aggregate: The contractor will furnish aggregates from sources that conform to the requirements shown in Table 1, and as specified in this section, unless otherwise shown on the plans. Provide aggregate stockpiles that meet the definition in this section for either 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. Supply mechanically crushed gravel or stone aggregates that meet the definitions in Tex-100-E. The ODR or Engineer will designate the plant as the sampling location. Samples must be from materials produced for the project. Surface Aggregate Classification (SAC) of supplied materials are to be listed in the most current TXDOT *Bituminous Rated Source Quality Catalog* (BRSQC) for material sources on the TxDOT's *Aggregate Quality Monitoring Program* (AQMP), or provided by the contractor. The Contractor will perform all other aggregate quality tests listed in Table 1. The contractor shall document all test results on the mixture design report. The ODR or Engineer may perform tests on independent or split samples to verify Contractor test results. Stockpile aggregates for each source and type separately. The contractor will determine aggregate gradations for mixture design and production testing based on the washed sieve analysis given in Tex-200-F, Part II. Do not add material to an approved stockpile from sources that do not meet the aggregate quality requirements of the TxDOT's *Bituminous Rated Source Quality Catalog* (BRSQC) unless otherwise approved. Aggregates from non-listed sources may be used only when tested by the Contractor and approved by the ODR.

1. Coarse Aggregate: Coarse aggregate stockpiles must have no more than 20% material passing the No. 8 sieve. Provide aggregates from sources listed in the BRSQC, or provide testing to verify compliance.

The contractor will provide coarse aggregate with at least the minimum SAC shown in Table 1 or as otherwise shown on the plans. SAC requirements apply only to aggregates used on the surface of travel lanes, unless otherwise shown

on the plans. The SAC for sources on the TxDOT's *Aggregate Quality Monitoring Program* (AQMP) is listed in the *Bituminous Rated Source Quality Catalog* (BRSQC).

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.

2. **Fine Aggregate:** Fine aggregates consist of manufactured sands, screenings, and field sands. Fine aggregate stockpiles must meet the gradation requirements in Table 2. Supply fine aggregates that are free from organic impurities. The ODR or Engineer may test the fine aggregate in accordance with Tex-408-A to verify the material is free from organic impurities. At most 15% of the total aggregate may be field sand or other uncrushed fine aggregate. With the exception of field sand, use fine aggregate from coarse aggregate sources that meet the requirements shown in Table 2, unless otherwise approved.

    a) If 10% or more of the 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 Tex-460-A and flat and elongated particles Tex-280-F.

Table 1
Aggregate Quality Requirements

Property	Test Method	Requirement
Coarse Aggregate		
SAC	AQMP	Class B, unless otherwise shown on the plans.
Deleterious material, %, max	Tex-217-F, Part I	1.5
Decantation, %, max	Tex-217-F, Part II	1.5
Los Angeles abrasion, %, max	Tex-410-A	40
Magnesium sulfate soundness, 5 cycles, %, max	Tex-411-A	30[1]
Coarse aggregate angularity, 2 crushed faces, %, min	Tex-460-A, Part I	85[2]
Flat and elongated particles @ 5:1, %, max	Tex-280-F	10
Fine Aggregate		
Linear shrinkage, %, max	Tex-107-E	3
Combined Aggregate[3]		
Sand equivalent, %, min	Tex-203-F	45

[1]Unless otherwise shown on the plans.

[2]Unless otherwise shown on the plans. Only applies to crushed gravel.

[3] Aggregates, without mineral filler, RAP, or additives, combined as used in the job-mix formula (JMF).

Table 2
Gradation Requirements for Fine Aggregate

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

3. RAP: RAP is salvaged, milled, pulverized, broken, or crushed asphalt pavement. When RAP is used, no more than the amounts shown in Table 3 will be accepted. When RAP is used, determine asphalt content and gradation for mixture design purposes. Perform other tests on RAP when shown on the plans. Crush or break RAP so that 100% of the particles pass the 2 inch sieve.

RAP used in ACP will be fractionated. Fractionated RAP is defined as having 2 or more RAP stockpiles whereas the RAP is divided into coarse and fine fractions. The coarse stockpile will contain only material retained by processing over a 1/2 inch screen unless otherwise approved. The fine RAP stockpile will contain only material passing the 1/2 inch screen unless otherwise approved. The maximum percentages of fractionated RAP may be comprised of coarse or fine fractionated RAP or the combination of both coarse and fine fractionated RAP. Utilize a separate cold feed bin for each stockpile of fractionated RAP used.

Do not use RAP contaminated with dirt or other objectionable materials. Do not use the RAP if the decantation value exceeds 5% and the plasticity index is greater than 8. Test the stockpiled RAP for decantation in accordance with the laboratory method given in Tex-406-A, Part I. Determine the plasticity index using Tex-106-E if the decantation value exceeds 5%. The decantation and plasticity index requirements do not apply to RAP samples with asphalt removed by extraction.

RAP from either Contractor-owned or City-owned sources, including RAP generated during the project, is permitted only when shown on the plans. City-owned RAP, if allowed for use, will be available at the location shown on the plans. Do not intermingle Contractor-owned RAP stockpiles with City-owned RAP stockpiles. Remove unused Contractor-owned RAP material from the project site upon completion of the project. Return unused City-owned RAP to the designated stockpile location.

Table 3
Maximum Allowable Recycled Binder (%)

	HMA	WMA
RAP	20[2]	30[1]
RAS	5[2]	30[1]

[1] A maximum of 30% of combined recycled binder is allowed When using WMA. RAP must be fractionated.
[2]For hot mix designs containing combined RAP and RAS use no more than 20% total recycled binder and no more than the stated maximum of each.

a) **Maintenance Mix:** Hot mix asphalt purchased by the City of Amarillo to be used by City forces for the construction and repair of city streets will have the following recycled material requirements:

The City of Amarillo herein is specifying that no more than 20% RAP as recycled binder will be allowable during the summer months, April thru September, and no more than 5% RAP as recycled binder will be allowable during the winter months, October thru March.

4. **RAS:** RAS is defined as processed asphalt shingle material from manufacturing of asphalt roofing shingles or from re-roofing residential structures. Post-manufactured RAS is defined as processed manufacturer's shingle scrap by-product. Post-consumer RAS is processed shingle scrap removed from residential structures. Use of post-manufactured RAS or post-consumer RAS (tear-offs) is permitted unless otherwise shown on the plans. Up to 5% RAS as recycled binder may be used separately or as a replacement for fractionated RAP in accordance with Table 3. Comply with all regulatory requirements stipulated for RAS by the TCEQ.

Process the RAS by ambient grinding or granulating such that 100% of the particles pass the 3/8 inch sieve when tested in accordance with Tex-200-F, Part I Perform a sieve analysis on processed RAS material before extraction (or ignition) of the asphalt binder.

Add sand meeting the requirements of Table 1 and Table 2 or fine RAP to RAS stockpiles if needed to keep the processed material workable. Any stockpile that contains RAS will be considered a RAS stockpile and be limited to no more than 5% of the HMA recycled binder.

Certify compliance of the RAS with TxDOT's DMS-11000, "Evaluating and Using Nonhazardous Recyclable Materials Guidelines." Treat RAS as an established non hazardous recyclable material if it has not come into contact with any hazardous materials. Use RAS from shingle sources on TxDOT's MPL or approved equal. Remove substantially all materials before use that are not part of the shingle, such as wood, paper, metal, plastic, and felt paper. Determine the deleterious content of RAS material for mixture design purposes in accordance with Tex-217-F, Part III. Do not use RAS if deleterious materials are more than 0.5% of the stockpiled RAS unless otherwise approved.

a) **Maintenance Mix:** Hot mix asphalt purchased by the City of Amarillo to be used by City forces for the construction and repair of city streets is to have the following recycled material requirements:

The City of Amarillo herein is specifying that no RAS will be allowable during the winter months, October thru March.

B. 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. Does 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:

1. Is sufficiently dry, free-flowing, and free from clumps and foreign matter;

2. Does not exceed 3% linear shrinkage when tested in accordance with Tex-107-E; and

3. Meets the gradation requirements in Table 4.

Table 4
Gradation Requirements for Mineral Filler

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

C. Baghouse Fines: Fines collected by the baghouse or other dust-collecting equipment may be reintroduced into the mixing drum.

D. Asphalt Binder: The contractor shall furnish the type and grade of performance-graded (PG) or asphalt cement (AC) asphalt binder specified on the plans in accordance with Subsection 4.23, "Asphalts, Oils, and Emulsions". The contractor will provide the ODR copies of all Bills of Lading.

E. Warm Mix Asphalt: Warm Mix Asphalt (WMA) is defined as hot mix asphalt that is produced within a target temperature discharge range of 215˚F and 275˚F using approved WMA additives or processes from TxDOT's Material Producers List.

WMA is allowed on all projects and is required when shown on the plans. When WMA is required, the maximum placement or target discharge temperature will be set at a value below 275˚F.

WMA additives or processes may be used to facilitate mixing and compaction of hot mix asphalt produced at target temperatures above 275˚F, however, such mixtures will not be identified as WMA.

F. 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.

Asphaltic mixtures with aggregate which exhibit stripping characteristics will be conditioned with either minimum 1% lime in accordance with DMS-6350, or liquid anti-stripping agent approved by the ODR, or Engineer

If lime or a liquid antistripping agent is used, add in accordance with Subsection 4.24, "Asphalt Antistripping Agents".

Do not add dry 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.

G. Mixture Design:

1. **Design Requirements:** Use a Level II specialist certified by The Texas Asphalt Paving Association-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 Tex-204-F, Part I, to design a mixture meeting the requirements listed in Tables 1 through 7. Use a Level II specialist to perform the Hamburg Wheel test and provide results with the mixture design. Furnish the ODR, or Engineer with copies of all testing for approval of the mixture design. If the design cannot be verified by the ODR, or Engineer, furnish another mixture design. If the

contractor uses a Super Pave Press to design the ACP mix it shall be noted on the design submitted to the ODR. Superpave press gyrations will be noted on contractor's design.

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

Provide the ODR, or Engineer with a mixture design report using the current TxDOT design forms. Include the following items in the report:

a) The combined aggregate gradation, source, specific gravity, and percent of each material used;

b) Results of all applicable tests;

c) The mixing and molding temperatures;

d) The signature of the Level II person or persons who performed the design; the date the mixture design was performed; and

e) A unique identification number for the mixture design.

Table 5
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	80.0–86.0
#8	22.0–36.0	29.0–43.0	32.0–44.0	35.0–46.0	38.0–48.0
#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
Design VMA[1], % Minimum					
–	12.0	13.0	14.0	15.0	16.0
Plant-Produced VMA, % Minimum					
–	11.5	12.5	13.5	14.5	15.5

[1]Voids in Mineral Aggregates.

Table 6
Laboratory Mixture Design Properties

Property	Test Method	Requirement
Target laboratory-molded density, %	Tex-207-F	97.0[1]
Design gyrations (Ndesign for SGC)	Tex-241-F	50[2]

[1]Unless otherwise shown on the plans.
[2]Adjust within a range of 35-100 gyrations when approved by ODR.

Table 7
Hamburg Wheel Test Requirements[1]

High-Temperature Binder Grade	Minimum # of Passes[2] @ 0.5" Rut Depth, Tested @ 122°F
PG 64[3] or lower	10,000
PG 70	15,000
PG 76 or higher	20,000

[1]Tested in accordance with Tex-242-F.
[2]May be decreased or waived during production when shown on the plans.
[3]If AC is used, it must show it meets the requirements of PG 64.

H. Job-Mix Formula Approval: The job-mix formula (JMF) is the combined aggregate gradation and target asphalt percentage used to establish target values for mixture production. JMF is the original laboratory mixture design used to produce the trial batch. The ODR, or Design Engineer and the Contractor will verify JMF based on plant-produced mixture from the trial batch unless otherwise approved. When WMA is used, document the additive or process used and recommended rate on JMF 1. The ODR or Engineer may accept an existing mixture design less than 1 year old and may waive the trial batch to verify JMF. If the JMF is not verified by the ODR, or Engineer from the trial batch, adjust the JMF or redesign the mix and produce as many trial batches as necessary to verify the JMF.

I. JMF Field Adjustments: The contractor will produce a mixture of uniform composition closely conforming to the approved JMF.

If, during initial days of production, the Contractor, ODR, or Engineer determines that adjustments to the JMF are necessary to achieve the specified requirements, or to more nearly match the aggregate production, the ODR may allow adjustment of the JMF within the tolerances of Table 8 without a laboratory redesign of the mixture.

The Contractor may adjust the asphalt content with the approval of the ODR to maintain desirable laboratory density near the optimum value while achieving other mix requirements.

III. Equipment: The Contractor will provide the required or necessary equipment in accordance with Subsection 4.25, "Equipment for Asphalt Concrete Pavement" and Subsection 4.26, "Weighing and Measuring Equipment."

IV. Construction: The Contractor shall design, produce, store, transport, place, and compact the specified paving mixture in accordance with the requirements of this Item. The Contractor will perform quality assurance (QA) testing at the scope and frequency outlined in the Quality Assurance section below. QA sampling and testing conducted by the Contractor will be reviewed by the ODR to determine payment and make acceptance decisions. The Contractor may perform quality control (QC) testing to additionally monitor production and placement operations. Contractor is allowed to submit Q/C testing to ODR.

A. Quality Assurance: The Contractor shall provide QA tests results immediately to the ODR via email or hard copy.

1. Production Acceptance (QA): The Contractor shall control the production process within the operational tolerances listed in Table 8. When more than 3 sieves are outside production tolerances of Table 8, the mix will be removed and replaced. When Asphalt Content is outside operational tolerances the mix will be removed and replaced. Q/A testing will be performed at the frequency shown in Table 8.

2. **Placement Acceptance (QA):** The Contractor shall control the placement process within the placement tolerances specified in Table 8. When outside specified tolerances the mix will be removed and replaced. Q/A testing will be performed at the frequency shown in Table 8.

   a) The Contractor shall core the pavement at random locations identified and marked by the ODR or his representative. The Contractor will notify the Inspector when coring will be done and the Inspector will witness each test. Cores will be taken in pairs. The Contractor will be required to take a minimum of 1 set of cores per 5000 SY or fraction thereof. If more than one street or alley is paved, a set of cores will be required on each alley or street. The ODR reserves the right to do additional testing at locations to be determined by ODR and paid for by the City.

Table 8
Quality Assurance

Description	**Test Method**	**Tolerance**	**Testing Frequencies**
Production			
Individual % retained for #8 sieve and larger	Tex-200-F or Tex-236-F	±5.0[1]	1 Per 5000 SY or fraction thereof
Individual % retained for sieves smaller than #8 and larger than #200		±3.0[1]	1 Per 5000 SY or fraction thereof
% passing the #200 sieve		±2.0[1]	1 Per 5000 SY or fraction thereof
Asphalt content, %	Tex-236-F	±0.5[1]	1 Per 5000 SY or fraction thereof
Theoretical Maximum Specific Gravity	Tex-227-F	Report results	1 Per 5000 SY or fraction thereof
Placement			
In-place Air Voids	Tex-207-F and Tex-227-F	3.8% to 8.5%	1 Per 5000 SY or fraction thereof [3]
Thickness		As shown in Table 10	1 Per 5000 SY or fraction thereof [3]
Ride for Arterial Streets	Tex-1001-S	65 to 95 IRI	All lanes[2]
Ride for Residential Streets		1/8" in 10 ft	All lanes[2]

[1]Allowable Difference from Design and/or JMF Target,

[2]Not required on overlays.

[3]Minimum 1 test per street or alley

B. Production Operations: The Contractor will perform a new trial batch when the plant or plant location is changed. The ODR may suspend production for noncompliance with this subsection. The Contractor will take corrective action and obtain approval to proceed after any production suspension for noncompliance.

1. **Storage and Heating of Materials:** Do not heat the asphalt binder above the temperatures specified in Subsection 4.23, "Asphalts, Oils, and Emulsions" or outside the manufacturer's recommended values. On a daily basis, provide the ODR with the records of asphalt binder and hot-mix asphalt discharge temperatures in accordance with Subsection 4.25, "Equipment for Asphalt Concrete Pavement". Unless otherwise approved, does not store mixture for a period long enough to affect the quality of the mixture.

2. **Mixing and Discharge of Materials:** Notify the ODR of the target discharge temperature and produce the mixture within 25°F of the target. The contractor will monitor the temperature of the material in the truck before shipping to ensure that it does not exceed 350°F. The City will not pay for or allow placement of any mixture produced at more than 350°F. Control the mixing time and temperature so that substantially all moisture is removed from the mixture before discharging from the plant.

   WMA shall be produced within the target discharge temperature range of 215˚F and 275˚F. Take corrective action any time discharge temperature of the WMA exceeds the target discharge range. The engineer may suspend production operations if the Contractor's corrective action is not successful at controlling the production temperature within the target range. Note that when WMA is produced, it may be necessary to adjust burners to ensure complete combustion such that no burner fuel residue remains in the mixture.

C. Hauling Operations: Before use, clean all truck beds to ensure mixture is not contaminated. When a release agent is necessary to coat truck beds, use a release agent on the approved list maintained by the TxDOT Construction Division.

D. Placement Operations: 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. Place the mixture to meet the typical section requirements and produce a smooth, finished surface with a uniform appearance and texture. Offset longitudinal joints of successive courses of hot mix by at least 6 inches. Place mixture so longitudinal joints on the surface course coincide with lane lines, or as directed. Ensure that all finished surfaces will drain properly. Place mixture within the compacted lift thickness shown in Table 10, unless otherwise shown on the plans or allowed.

1. **Weather Conditions:** Hot mix open season is shown in Subsection 4.23, "Asphalt, Oils and Emulsions.

The contractor may place mixture when the air temperature is above 40°F and rising and the roadway surface temperature is 60°F or higher unless otherwise approved. If the temperature is 50°F and falling, paving operations will cease. Measure the roadway surface temperature with a handheld infrared thermometer. Unless otherwise shown on the plans, place mixtures only when weather conditions and moisture conditions of the roadway surface are suitable in the opinion of the ODR, or Engineer. Contractors may pave at temperatures 50˚F roadway temperatures when using WMA.

2. **Tack Coat:** Clean the surface before placing the tack coat. Unless otherwise approved, apply tack coat uniformly at the rate directed by the ODR. The ODR will set the rate between 0.04 and 0.10 gallons of residual asphalt per square yard of surface area. Apply a thin, uniform tack coat to all pavement surfaces, contact surfaces of curbs, structures, and all joints. Prevent splattering of tack coat when placed adjacent to curb, gutter, and structures. The ODR may use Tex-243-F to verify that the tack coat has adequate adhesive properties. The ODR may suspend paving operations until there is adequate adhesion.

   Do not dilute emulsified asphalts at the terminal, in the field, or at any other location before use. If required, verify that emulsified asphalt proposed for use meets the minimum residual asphalt percentage specified in Subsection 4.23, "Asphalts, Oils, and Emulsions."

3. **Prime Coat:** 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. Use material in accordance with Subsection 4.23, "Asphalts, Oils, and Emulsions."

   Application must conform to Subsection 4.28 "Prime." Prime will not be placed on frozen base.

   Do not permit traffic, hauling, or placement of subsequent courses over freshly constructed prime coats. If the primed surface has accumulated an unsatisfactory amount of dust, the base material shall be swept and if required either re-primed or a tack coat applied. Approval needs to be given by ODR before mix can be placed. Maintain the primed surface until placement of subsequent courses or acceptance of the work.

E. Lay-Down Operations

1. **Minimum Mixture Placement Temperatures:** Use Table 9 for suggested minimum mixture placement temperatures.

2. **Windrow Operations:** When hot mix is placed in windrows, operate windrow pickup equipment so that substantially all the mixture deposited on the roadbed is picked up and loaded into the paver.

3. **Placement against Structures:** When placed adjacent to curb and gutter or other structures the surface shall be finished uniformly high so that when completed it will be ¼ inch above the curb and gutter or other concrete structures.

Table 9
Suggested Minimum Mixture Placement Temperature

High-Temperature Binder Grade	Minimum Placement Temperature (Before Entering Paver)	WMA Minimum Placement Temperature (Before Entering Paver)
PG 64[1] or lower	260°F	215˚F[2]
PG 70	270°F	215˚F[2]
PG 76	280°F	215˚F[2]
PG 82 or higher	290°F	215˚F[2]

[1] If AC is used, it must meet the requirements of PG 64.

F. **Compaction:** Use air void control unless ordinary compaction control is specified on the plans. The Contractor will set a rolling pattern to reach maximum compaction. Rolling pattern with be determined by qualified personnel for each new paving operation. Avoid displacement of the mixture. If displacement occurs, correct to the satisfaction of the ODR. Ensure pavement is fully compacted before allowing rollers to stand on the pavement. 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. Unless otherwise directed, operate vibratory rollers in static mode when not compacting, when changing directions, or when the plan depth of the pavement mat is less than 1-1/2 inches. 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.

Use tamps to thoroughly compact the edges of the pavement along curbs, headers, and similar structures and in locations that will not allow thorough compaction with the rollers. The ODR may require rolling with a trench roller on widened areas, in trenches, and in other limited areas.

1. **Air Void Control:** Compact dense-graded hot-mix asphalt to obtain from 3.8% to 8.5% in-place air voids. The Contractor will test density and depth a minimum of one test per 5000 square yards per street or alley. The Contractor will measure in-place air voids in accordance with Tex-207-F and Tex-227-F. The Contractor will average the values obtained for all tests to determine the

theoretical maximum specific gravity. Test results will be submitted to the City directly from the testing lab within 2 days of mix being placed.

a) **Rollers:** Furnish the type, size, and number or rollers required for compaction. Use a pneumatic-tire roller to seal the surface, unless otherwise shown on the plans. Use additional rollers as required to remove any roller marks.

b) **Placement Areas Subject to Removal and Replacement:** If after testing, an area is identified with results of air voids higher than 8.5% or lower than 3.8%, the contractor may take additional cores at 50 foot spacing to define the limits of deficiency. If any two consecutive cores show air voids out of the specified range the area between the two cores plus half the distance to the nearest passing core must be removed and replaced. The Contractor will obtain cores in the presence of the ODR.

2. **Ordinary Compaction Control:** Ordinary compaction will be allowed only on maintenance or small utilities projects, unless otherwise specified. The contractor will furnish the type, size, and number or rollers required for compaction. Furnish at least 1 medium pneumatic-tire roller (minimum 12-ton weight). Use the control strip method given in Tex-207-F, Part IV, to establish rolling patterns that achieve maximum compaction. Follow the selected rolling pattern unless changes that affect compaction occur in the mixture or placement conditions. When such changes occur, establish a new rolling pattern. Compact the pavement to meet the requirements of the plans and specifications.

When rolling with the 3-wheel, tandem or vibratory rollers, start by first rolling the joint with the adjacent pavement and then continue by rolling longitudinally at the sides. Proceed toward the center of the pavement, overlapping on successive trips by at least 1foot, unless otherwise directed. Make alternate trips of the roller slightly different in length. On super elevated curves, begin rolling at the low side and progress toward the high side unless otherwise directed.

G. **Thickness:** Design thickness shall be as shown on the plans. Minimum thickness of hot-mix asphalt is shown in Table 10.

1. If quality assurance testing show more than ¼ inch deficiency from the specified minimum thickness prior to being trimmed, the hot-mix surface shall be considered deficient with respect to thickness, and the deficiency shall be rectified by removal and replacement at the specified thickness at Contractor's sole expense.

2. The Contractor may take additional cores at 50 foot spacing to define the limits of deficiency. If any two consecutive cores show deficient thickness the area between the two cores plus half the distance to the nearest passing core must be removed and replaced.

3. No additional compensation will be made to the Contractor for thickness of hot-mix surface greater than specified.

4. The Contractor will obtain the cores within 2 working days of the time the placement is completed. Two 6-inch diameter cores side-by-side from within 1 foot of the random location provided for the placement test. 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. For Type C, Type D, and Type F mixtures, 4 inch diameter cores are allowed.

Table 10
Required Core Height

Mixture Type	Minimum Untrimmed Core Height inch Eligible for Density Testing
A	2.00
B	1.75
C	1.50
D	1.25
F	0.75

H. Irregularities: The Contractor will 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 ODR may suspend production or placement operations until the problem is corrected.

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

I. Maintenance Mix: The vendor, at his expense, will be required to test asphaltic mixture on a monthly basis. The vendor will be required to supply to the City a copy of certified test results. The tests required are asphalt content and gradations shown in Table 5.

V. Ride Quality:

A. Type 1 Surface test will be used unless otherwise shown on the plans.

Type 1 Surface Test will be determined by the ODR test driving the roadway. Any locations determined to be corrected will be fixed by diamond grinding and treated with emulsion or removal and replacement.

1. Type 2 Surface Test will use a high speed or lightweight inertial profiler certified at the Texas Transportation Institute. Provide the ODR with equipment

certification documentation. If the IRI is determined to exceed 65 inches per mile corrective action shall be performed by diamond grinding, or other methods approved by the ODR. If the IRI exceeds 95 inches per mile the pavement shall be removed and replaced at the contractor's expense. Areas immediately adjacent to obstructions in the roadway such as manholes or street intersections shall be omitted from the surface test results. Areas excluded shall be approved by the ODR.

VI. Measurement: Hot mix will be measured by the Square Yard, which includes asphalt, aggregate, and additives.

VII. Payment: Work performed and materials furnished in accordance with this subsection and measured as provided under "Measurement" will be paid for at the unit price bid for "Dense-Graded Hot-Mix Asphalt" of the type, surface aggregate classification, and binder specified. These prices are full compensation for surface preparation, materials including prime coat, tack coat, placement, equipment, labor, tools, testing, and incidentals. Trial batches will not be paid for unless they are incorporated into pavement work approved by the City.

Diamond grinding and emulsion treatment and removal and replacement will be done at the contractor's sole expense.

LAST PAGE OF SECTION

Subsection 4.18
Dense-Graded Hot-Mix Asphaltic Overlay

I. Scope: The contractor will construct a pavement layer composed of a compacted, dense-graded mixture of aggregate and asphalt binder mixed hot in a mixing plant.

II. Material: Materials for this subsection shall conform to Section 4.17.II, "Materials."

III. Equipment: The Contractor will provide the required or necessary equipment in accordance with Subsection 4.25, "Equipment for Asphalt Concrete Pavement" and Subsection 4.26, "Weighing and Measuring Equipment."

IV. Construction: The Contractor shall design, produce, store, transport, place, and compact the specified paving mixture in accordance with the requirements of this Subsection. The Contractor will perform quality assurance (QA) testing at the scope and frequency outlined in the Quality Assurance section below. QA sampling and testing conducted by the Contractor will be reviewed by the ODR to determine payment and make acceptance decisions. The Contractor may perform quality control (QC) testing to additionally monitor production operations. Contractor is allowed to submit Q/C testing to ODR.

A. Quality Assurance: The Contractor shall provide QA test results immediately to the ODR via email or hard copy.

1. **Production Acceptance:** The Contractor shall control the production process within the operational tolerances listed in Table 1. When more than 3 sieves are outside production tolerances of Table 1, the mix will be removed and replaced. When asphalt content is outside operational tolerances the mix will be removed and replaced. Q/A testing will be performed at the frequency shown in Table 1.

2. **Placement Acceptance:** The City will establish an average density every 1,500 square yards of existing paving or a maximum of 10 nuclear density tests on each street. A street may be segmented for this determination if the total length is greater than 1 mile or as determined by the ODR. The locations and average density will be identified to the contractor prior to overlay placement. At a minimum, the City will perform nuclear density testing at the originally tested locations after the installation of the proposed overlay for QA purposes. The average density of the proposed material must achieve a density equal to or greater than the average density of the existing hot mix. In the event the new overlay average density is less than the existing average density, the area represented by the failing test must be removed and replaced. The area represented by a failing individual test is considered to be the area up to the adjacent passing test. Procedures and methods outlined in ASTM D2950 and this subsection shall be used for QA purposes.

Table 1

Quality Assurance

Production	Test Method	Tolerances	Testing Frequencies
Individual % retained for #8 sieve and larger	Tex-200-F or Tex-236-F	±5.0[1]	1 per 5000 SY or fraction thereof
Individual % retained for sieves smaller than #8 and larger than #200		±3.0[1]	1 per 5000 SY or fraction thereof
% passing the #200 sieve		±2.0[1]	1 per 5000 SY or fraction thereof
Asphalt content, %	Tex-236-F	±0.5[1]	1 per 5000 SY or fraction thereof

[1] Allowable differences from design and/or JMF target.

B. Production Operations: The contractor will perform a new trial batch when the plant or plant location is changed. The ODR may suspend production for noncompliance with this Item. The contractor will take corrective action and obtain approval to proceed after any production suspension for noncompliance.

1. **Storage and Heating of Materials:** Do not heat the asphalt binder above the temperatures specified in Subsection 4.23, "Asphalts, Oils, and Emulsions" or outside the manufacturer's recommended values. On a daily basis, provide the ODR with the records of asphalt binder and hot-mix asphalt discharge temperatures in accordance with Subsection 4.25, "Equipment for Asphalt Concrete Pavement". Unless otherwise approved, does not store mixture for a period long enough to affect the quality of the mixture.

2. **Mixing and Discharge of Materials:** Notify the ODR of the target discharge temperature and produce the mixture within 25°F of the target. The contractor will monitor the temperature of the material in the truck before shipping to ensure that it does not exceed 350°F. The City will not pay for or allow placement of any mixture produced at more than 350°F. Control the mixing time and temperature so that substantially all moisture is removed from the mixture before discharging from the plant.

C. Hauling Operations: Before use, clean all truck beds to ensure mixture is not contaminated. When a release agent is necessary to coat truck beds, use a release agent on the approved list maintained by the TxDOT Construction Division.

D. Placement Operations: 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. Place the mixture to meet the typical section requirements and produce a smooth, finished surface with a uniform appearance and texture. Offset longitudinal joints of successive courses of hot mix by at least 6 inches. Place mixture so longitudinal joints on the surface course coincide with lane lines, or as directed. Ensure that all finished surfaces will drain properly.

1. **Weather Conditions:** Hot mix open season is shown in Subsection 4.23, "Asphalt, Oils and Emulsions."

The contractor may place mixture when the air temperature is above 40°F and rising and the roadway surface temperature is 60°F or higher unless otherwise approved. If the temperature is 50°F and falling, paving operations will cease. Measure the roadway surface temperature with a handheld infrared thermometer. Unless otherwise shown on the plans, place mixtures only when weather conditions and moisture conditions of the roadway surface are suitable in the opinion of the ODR, or Engineer.

2. **Tack Coat:** Clean the surface before placing the tack coat. Unless otherwise approved, apply tack coat uniformly at the rate directed by the ODR. The ODR will set the rate between 0.04 and 0.10 gallons of residual asphalt per square yard of surface area. Apply a thin, uniform tack coat to all pavement surfaces, contact surfaces of curbs, structures, and all joints. Prevent splattering of tack coat when placed adjacent to curb, gutter, and structures. The ODR may use Tex-243-F to verify that the tack coat has adequate adhesive properties. The ODR may suspend paving operations until there is adequate adhesion.

E. Lay-Down Operations

1. Placement requirements

a) At no time will a street be completely closed;

b) Only 2 streets can be milled at any given time including the one being overlaid;

c) Before paving begins on a street, the Contractor's Superintendent and the City Engineering Project Representative shall review the street for conflicts with access routes to and from emergency services, buildings and parking garages. The Contractor may be required to distribute information concerning closings of driveways and alternative access routes before beginning work on any one street;

d) The Contractor shall maintain access to all facilities during construction. Streets that serve restaurants may receive special scheduling to reduce traffic conflicts during high volume periods such as, but not limited to, lunch periods; and

e) No work shall be allowed within school zones while school is in session.

2. **Minimum Mixture Placement Temperatures:** Use Table 2 for suggested minimum mixture placement temperatures.

3. **Windrow Operations:** When hot mix is placed in windrows, operate windrow pickup equipment so that substantially all the mixture deposited on the roadbed is picked up and loaded into the paver.

4. **Placement against Structures:** When placed adjacent to curb and gutter or other structures the surface shall be finished uniformly high so that when completed it will be ¼ inch above the curb and gutter or other concrete structures.

Table 2
Suggested Minimum Mixture Placement Temperature

High-Temperature Binder Grade	Minimum Placement Temperature (Before Entering Paver)
PG 64[1]or lower	260°F
PG 70	270°F
PG 76	280°F
PG 82 or higher	290°F

[1]If AC is used, it must meet the requirements of PG 64.

F. Compaction: The Contractor will set a rolling pattern to reach maximum compaction. Rolling pattern with be determined by qualified personnel for each new paving operation. Avoid displacement of the mixture. If displacement occurs, correct to the satisfaction of the ODR. Ensure pavement is fully compacted before allowing rollers to stand on the pavement. 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. Furnish the type, size, and number or rollers required for compaction. Use a pneumatic-tire roller to seal the surface, unless otherwise shown on the plans. Use additional rollers as required to remove any roller marks. Unless otherwise directed, operate vibratory rollers in static mode when not compacting, when changing directions. 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.

Use tamps to thoroughly compact the edges of the pavement along curbs, headers, and similar structures and in locations that will not allow thorough compaction with the rollers. The ODR may require rolling with a trench roller on widened areas, and in other limited areas.

G. Irregularities: The contractor will 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 ODR may suspend production or placement operations until the problem is corrected.

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

H. Temporary Markings: The Contractor shall place removable temporary pavement markings that meet the requirements of TxDOT's DMS-8242 "Temporary Flexible, Reflective Roadway Marker Tabs" before opening roadway to traffic.

I. Crack Sealing: During the one year warranty period the cracks in the overlaid areas will be sealed. Crack sealing will be in accordance to Subsection 4.29, "Cleaning and Sealing Joints and Cracks."

V. Measurement: Hot mix will be measured by the square yard.

VI. Payment: Work performed and materials furnished in accordance with this subsection and measured as provided under "Measurement" will be paid for at the unit price bid for "Dense-Graded Hot-Mix Asphalt" of the type, surface aggregate classification, and binder specified. These prices are full compensation for surface preparation, materials including temporary tabs, tack coat, placement, equipment, labor, tools, testing, crack sealing and incidentals. Trial batches will not be paid for unless they are incorporated into pavement work approved by the City.

Last Page of Section

Subsection 4.19
Hot-Mix Cold-Laid Asphalt Concrete Pavement

I. Scope: Construct a temporary pavement layer as directed by the City of Amarillo composed of a compacted mixture of aggregate and asphalt binder mixed hot in a mixing plant. This subsection governs mixtures designed for cold placement, defined as placement temperatures below 175°F. If the mixture placement temperature is greater than 175°F, then design, produce, place, and compact the mixture in accordance with Subsection 4.17, "Dense Graded Hot Mix Asphalt."

II. Material: Furnish uncontaminated materials of uniform quality that meet the requirements of the plans and specifications. The contractor will notify the ODR (Owner Designated Representative) of all material sources. Notify the ODR before changing any material source or formulation. When the Contractor makes a source or formulation change, Contractor shall provide verification that the requirements of this subsection are met and the ODR, or Engineer may require a new laboratory mixture design, trial batch, or both. The ODR or Engineer may perform sampling and testing of project materials at any time during the project to verify compliance.

1. **Aggregate:** Furnish aggregates from sources that conform to the requirements shown in Table 1, and as specified in this section, unless otherwise shown on the plans. Provide aggregate stockpiles that meet the definition in this section for either coarse aggregate or fine aggregate. Supply mechanically crushed gravel or stone aggregates that meet the definitions in Tex-100-E. The ODR or Engineer will designate the plant as the sampling location. Samples must be from materials produced for the project. Surface Aggregate Classification (SAC) of supplied materials are to be listed in the most current *Bituminous Rated Source Quality Catalog* (BRSQC) for material sources on the *Aggregate Quality Monitoring Program* (AQMP), or provided by the contractor. The Contractor will perform all other aggregate quality tests listed in Table 1. The Contractor shall document all test results on the mixture design report. The ODR or Engineer may perform tests on independent or split samples to verify Contractor test results. Stockpile aggregates for each source and type separately. The contractor will determine aggregate gradations for mixture design and production testing based on the washed sieve analysis given in Tex-200-F, Part II. Do not add material to an approved stockpile from sources that do not meet the aggregate quality requirements of the *Bituminous Rated Source Quality Catalog* (BRSQC) unless otherwise approved. Aggregates from non-listed sources may be used only when tested by the Contractor and approved by the ODR.

2. **Coarse Aggregate:** Coarse aggregate stockpiles must have no more than 20% material passing the No. 8 sieve. Provide aggregates from sources listed in the BRSQC, or provide testing to verify compliance.

   The contractor will provide coarse aggregate with at least the minimum SAC shown in Table 1 or as otherwise shown on the plans. SAC requirements apply

only to aggregates used on the surface of travel lanes, unless otherwise shown on the plans. The SAC for sources on the AQMP is listed in the BRSQC.

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.

3. **Fine Aggregate:** Fine aggregates consist of manufactured sands, screenings, and field sands. Fine aggregate stockpiles must meet the gradation requirements in Table 2. Supply fine aggregates that are free from organic impurities. The ODR or Engineer may test the fine aggregate in accordance with Tex-408-A to verify the material is free from organic impurities. At most 15% of the total aggregate may be field sand or other uncrushed fine aggregate. With the exception of field sand, use fine aggregate from coarse aggregate sources that meet the requirements shown in Table 2, unless otherwise approved.

   If 10% or more of the 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 Tex-460-A and flat and elongated particles Tex-280-F.

Table 1
Aggregate Quality Requirements

Property	Test Method	Requirement
Coarse Aggregate		
SAC	AQMP	Class B, unless otherwise shown on the plans.
Deleterious material, %, max	Tex-217-F, Part I	1.5
Decantation, %, max	Tex-217-F, Part II	1.5
Los Angeles abrasion, %, max	Tex-410-A	40
Magnesium sulfate soundness, 5 cycles, %, max	Tex-411-A	30[1]
Coarse aggregate angularity, 2 crushed faces, %, min	Tex 460-A, Part I	85[2]
Flat and elongated particles @ 5:1, %, max	Tex-280-F	10
Fine Aggregate		
Linear shrinkage, %, max	Tex-107-E	3
Combined Aggregate[3]		
Sand equivalent, %, min	Tex-203-F	45

[1]Unless otherwise shown on the plans.

[2]Unless otherwise shown on the plans. Only applies to crushed gravel.

[3]Aggregates, without mineral filler or additives, combined as used in the job-mix formula (JMF).

Table 2
Gradation Requirements for Fine Aggregate

Sieve Size	% Passing by Weight or Volume
3/8"	100
#8	70–100
#200	0–15

B. 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. Does 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:

1. Is sufficiently dry, free-flowing, and free from clumps and foreign matter;

2. Does not exceed 3% linear shrinkage when tested in accordance with Tex-107-E; and

3. Meets the gradation requirements in Table 3.

Table 3
Gradation Requirements for Mineral Filler

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

C. Baghouse Fines: Fines collected by the baghouse or other dust-collecting equipment may be reintroduced into the mixing drum.

D. Asphalt Binder: The contractor shall furnish the type and grade of performance-graded (PG) or asphalt cement (AC) asphalt binder specified on the plans in accordance with Item 4.23, "Asphalts, Oils, and Emulsions". The contractor will provide the ODR copies of all Bills of Lading.

E. Primer: Provide an approved asphalt primer consisting of a blend of aspahlt cement and hydrocarbon volatiles.

F. Water: Provide water that meets the requirements of Subsection 4.32, "Sprinkling."

G. 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.

Asphaltic mixtures with aggregate which exhibit stripping characteristics will be conditioned with either minimum 1% lime in accordance with DMS-6350 "Lime and Lime Slurry", or liquid anti-stripping agent approved by the ODR, or Engineer

If lime or a liquid antistripping agent is used, add in accordance with Subsection 4.24, "Asphalt Antistripping Agents".

Do not add dry 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.

H. Tack Coat: Furnish CSS-1H, SS-1H, or a performance-graded (PG) binder with a minimum high temperature grade of PG 58 for tack coat in accordance with Subsection 4.23 "Asphalts, Oils, and Emulsions." Specialized or preferred tack materials may be allowed or required when shown in the plans. Do not dilute emulsified asphalts at the terminal, in the field, or at any other location before use.

III. Equipment: Provide required or necessary equipment in accordance with Subsection 4.25, "Equipment for Hot-Mix Asphalt Concrete."

IV. Construction: Design, produce, store, transport, place, and compact the specified paving mixture in accordance with the requirements of the subsection. Provide the mix design unless otherwise shown in the plans. The City may perform quality assurance (QA) testing. Provide quality control (QC) testing as needed to meet the requirements of this subsection.

A. Mixture Design:

1. Design Requirements: Use the typical weight design example given in Tex-204-F, Part I, to design a mixture that consists of a uniform mixture of aggregate, asphalt material, primer, additives, and water, if allowed, which meets the requirements listed in Tables 4 and 5. Furnish the ODR, or Engineer with copies of all testing for approval of the mixture design. Ensure that the mixture leaves the plant in a workable condition. Provide materials that remain workable in a stockpile for at least 6 months.

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

Provide the ODR, or Engineer with a mixture design report using the current TxDOT design forms. Include the following items in the report:

B. Job-Mix Formula Approval: The job-mix formula (JMF) is the combined aggregate gradation and target asphalt percentage used to establish target values for mixture production. JMF is the original laboratory mixture design used to produce the trial batch. The ODR, or Design Engineer and the Contractor will verify JMF based on

plant-produced mixture from the trial batch unless otherwise approved. The ODR or Engineer may accept an existing mixture design less than 1 year old and may waive the trial batch to verify JMF. If the JMF is not verified by the ODR, or Engineer from the trial batch, adjust the JMF or redesign the mix and produce as many trial batches as necessary to verify the JMF.

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	80.0–86.0
#8	22.0–36.0	29.0–43.0	32.0–44.0	35.0–46.0	38.0–48.0
#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
Design VMA[1], % Minimum					
–	12.0	13.0	14.0	15.0	16.0
Plant-Produced VMA, % Minimum					
–	11.5	12.5	13.5	14.5	15.5

[1]Voids in Mineral Aggregates.

Table 5
Laboratory Mixture Design Properties

Property	Test Method	Requirement
Target laboratory-molded density, %[1]	Tex-207-F	92.5 ± 1.5
Hveem stability, Min	Tex-208-F	35
Hydrocarbon-volatile content, % Max	Tex-213-F	0.6
Moisture content, %,Max[2]	Tex-212-F	1.0

[1]Unless otherwise shown on the plans.
[2]Unless otherwise approved

C. Production Operations: The Contractor will perform a new trial batch when the plant or plant location is changed. The ODR may suspend production for noncompliance with this Item. The contractor will take corrective action and obtain approval to proceed after any production suspension for noncompliance.

1. Stockpiling of Aggregates: Provide a smooth and well-drained area, cleared of trash, weeds, and grass. Build stockpiles in a manner that will minimize aggregate degradation and segregation. Avoid contamination and mixing of stockpiles. Provide aggregate stockpiles for a minimum of 2 days' production before beginning plant operations. Maintain at least 2 day aggregate supply through the course of the project unless otherwise directed. Stockpile aggregate for each source and type separately. The ODR may reject stockpiled materials that come in contact with the earth or other objectionable material.

2. Storage and Heating of Asphalt Materials: Do not heat the asphalt binder above the temperatures specified in Subsection 4.23, "Asphalts, Oils, and Emulsions" or outside the manufacturer's recommended values.

3. Storage of the Asphalt Mixture: Store the asphalt mixture in a surge-storage system or in a stockpile. Provide a smooth and well-drained area, cleared of trash, weeds, and grass if the asphalt mixture is stored in a stockpile. Build stockpiles in a manner that will minimize aggregate degradation and segregation. Avoid contamination and mixing of stockpiles.

4. Mixing and Discharge of Materials: Produce the mixture at a discharge temperature between 145°F and 275°F, as directed. Do not allow the temperature to vary from the selected temperature by more than 25°F. The City will not pay for or allow placement of any mixture produced above 300°F.

5. Moisture Content: Furnish the mixture at a moisture content of no more than 1% by weight when discharged from the mixer, unless otherwise shown on the plans or approved. Cease operations at moisture contents above 1% until corrective actions reduce moisture content.

D. Hauling Operations: Before use, clean all truck beds to ensure mixture is not contaminated. When a release agent is necessary to coat truck beds, use a release agent on the approved list maintained by the TxDOT Construction Division.

E. Placement Operations: 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. Place the mixture on the road below 175°F. Place the mixture

to meet the typical section requirements and produce a smooth, finished surface with a uniform appearance and texture. Offset longitudinal joints of successive courses of hot mix by at least 6 inches. Place mixture so longitudinal joints on the surface course coincide with lane lines, or as directed. Ensure that all finished surfaces will drain properly.

When desired, dump the asphalt mixture in a windrow and then place in the finishing machine with windrow pickup equipment unless otherwise shown on the plans. Prevent the windrow pickup equipment from contaminating the mixture.

Defer compaction after placing the paving mixture, as directed. Allow the previous course to dry and cure before placing the next course when placing more than one pavement course. Consider the course cured if the hydrocarbon volatile content of the mixture is 0.4% or less by weight of the mixture when tested according to Tex-213-F unless otherwise directed.

Use a motor grader to spread the mixture when shown on the plans or approved. Thoroughly aerate the mixture and spread into place with a power motor grader in a uniform layer. Placement in narrow strips or small irregular areas may require hand spreading.

1. Weather Conditions: The contractor may place mixture when the air temperature is above 40°F and rising and the roadway surface temperature is 60°F or higher unless otherwise approved. If the temperature is 50°F and falling, paving operations will cease. Measure the roadway surface temperature with a handheld infrared thermometer. Unless otherwise shown on the plans, place mixtures only when weather conditions and moisture conditions of the roadway surface are suitable in the opinion of the ODR, or Engineer.

2. Tack Coat: Clean the surface before placing the tack coat. Unless otherwise approved, apply tack coat uniformly at the rate directed by the ODR. The ODR will set the rate between 0.04 and 0.10 gallons of residual asphalt per square yard of surface area. Apply a thin, uniform tack coat to all pavement surfaces, contact surfaces of curbs, structures, and all joints. Prevent splattering of tack coat when placed adjacent to curb, gutter, and structures. The ODR may suspend paving operations until there is adequate adhesion.

Do not dilute emulsified asphalts at the terminal, in the field, or at any other location before use. If required, verify that emulsified asphalt proposed for use meets the minimum residual asphalt percentage specified in Subsection 4.23, “Asphalts, Oils, and Emulsions”.

F. Compaction: Furnish the type and size, and number of rollers required for compaction as approved. Furnish at least one medium pneumatic-tire roller (minimum 12-ton weight). Use the control strip method given in Tex-207-F, Part IV, to establish rolling patterns that aceive maximum compaction. The Contractor will set a rolling pattern to reach maximum compaction. Follow the selected rolling pattern unless changes that affect compaction occur in the mixture or placement conditions. Establish a new rolling patter when such changes occur. Compact the pavement to the cross-section of the finished paving mixture meeting the requirements of the plans and specifications. Operate vibratory rollers in static mode when not compacting, when changing directions, or when the plan depth of the pavement mat is less than 1-1/2 inches**.**

Start by first rolling the joint with the adjacent pavement and then continue by rolling longitudinally at the sides when rolling with 3-wheel tandem or vibratory rollers. Proceed toward the center of the pavement, overlapping on successive trips by at least 1 foot. Make alternative trips of the roller slightly different in length. .

Avoid displacement of the mixture. If displacement occurs, correct to the satisfaction of the ODR. Ensure pavement is fully compacted before allowing rollers to stand on the pavement. 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. Unless otherwise directed.

Use tamps to thoroughly compact the edges of the pavement along curbs, headers, and similar structures and in locations that will not allow thorough compaction with the rollers. The ODR may require rolling with a trench roller on widened areas, in trenches, and in other limited areas.

Allow the compacted pavement to cool to 100°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.

1. Production Testing and Operational Tolerances: The aggregate gradation and the asphalt binder content of the produced mixture must not vary from the design by more than the percentage point tolerances shown in Table 6. The gradation of the produced mixture may fall outside the master grading limits for any of the sieve sizes from the 1-1/2 inch through the No. 50 sieve, if it is within the design tolerances. The aggregate gradation of the No. 200 sieve may not exceed the master gradations shown in Table 4. Any sieve size shown in Table 4 with 100% passing requirements will be allowed a 2% tolerance before the material is considered out of specification.

Cease production if 3 consecutive tests indicate that the material produced exceeds the tolerance shown in Table 6 for any individual sieve or lab molded density until corrective actions are taken and the results approved.

Cease production if 2 consecutive tests indicate that the asphalt binder content tolerances shown in Table 6 are exceeded until corrective actions are taken and the results approved.

Cease production if the Hveem Stability shown in Table 5 is not met for 3 consecutive tests until corrective actions are taken and the results approved.

Table 6
Operational Tolerances

Property	**Test Method**	**Operational Tolerance from Design**
Individual % retained for sieve sizes smaller than 1 ½" and larger than #8	Tex-200-F	±5.0
Individual % retained for sieve sizes smaller than #8		±3.0
Asphalt binder content, %	Tex-236-F	±0.3
Laboratory-molded density, %	Tex-207-F	±1.0

G. Irregularities: The Contractor will 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 ODR may suspend production or placement operations until the problem is corrected.

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

H. Maintenance Mix: The vendor, at his expense, will be required to test asphaltic mixture on a monthly basis. The vendor will be required to supply to the City a copy of certified test results. The tests required are asphalt content and gradations shown in Table 4.

V. Measurement: Cold laid hot mix will be measured by the ton of composite asphaltic mixture of the type used in the completed and accepted work. Measure the weight on scales in accordance with Subsection 4.26, "Weighing and Measuring Equipment."

For mixture produced by weigh-batch plant or a modified weigh-batch plant, measurement will be determined on the batch scales unless surge-storage or stockpiling is used. Keep records of the number of batches, batch design, and the weight of the composite asphalt concrete mixture. The composite asphalt concrete mixture is defined as the asphalt, primer, aggregate, additives, and residual moisture that is not designated to be deducted. Where surge-storage or stockpiling is used, measurement of the material taken from the surge-storage bin or stockpile will be made on truck scales or suspended hopper scales.

VI. Payment: Work performed and materials furnished in accordance with this Subsection and measured as provided under "Measurement" will be paid for at the unit

price bid for “Hot-Mix Cold-Laid Asphalt Concrete Pavement” of the type and binder specified.

These prices are full compensation for surface preparation, materials including prime coat, tack coat, placement, equipment, labor, tools, testing, and incidentals. Trial batches will not be paid for unless they are incorporated into pavement work approved by the City.

LAST PAGE OF SECTION

Subsection 4.20
Construction Pavement Markings

I. Scope: This subsection includes the furnishing, placement, maintenance, and prompt removal of reflectorized, work zone, and prefabricated pavement markings. Provide traffic control for placement, testing and removal.

II. Materials: Provide thermoplastic, paint and beads, prefabricated pavement markers, temporary flexible reflective marker tabs, or other materials approved for pavement markings.

A. For placing pavement markers supply materials meeting:

1. DMS-8200, "Traffic Paint;"

2. DMS-8220, "Hot Applied Thermoplastic;"

3. DMS-8240, "Permanent Prefabricated Pavement Markings;"

4. DMS-8241, "Temporary (Removable) Prefabricated Pavement Markings;"

5. DMS-8242, "Temporary Flexible, Reflective Roadway Marker Tabs;" and

6. DMS-8290, "Glass Beads."

B. For removal of pavement marking furnish materials in accordance with:

1. Subsection 4.23, "Asphalts, Oils, and Emulsions;" and

2. Subsection 4.16, "Seal Coat."

C. Terminology

1. Type I Markings: Hot placed Thermoplastic

2. Type II Markings: Paint and beads

3. Prefabricated Markings: Pre-molded thermoplastic

III. Equipment:

A. Application Requirements. Use equipment that:

1. Is maintained in satisfactory condition;

2. Applies beads by an automatic dispenser attached to the pavement marking equipment in such a way that the beads are dispensed uniformly and almost instantly upon the marking being applied to the road surface. The bead dispenser must have an automatic cut-off control;

3. Has an automatic cut-off device with manual operating capabilities to provide clean, square marking ends;

4. Is capable of producing the types and shapes of profiles specified; and

5. Can provide continuous mixing and agitation of the pavement marking material.

B. Material Placement Requirements: Use equipment that can place:

1. A centerline and no passing barrier-line configuration consisting of 1 broken line and 1 solid line at the same time to the alignment, spacing, and thickness;

2. Lines with clean edges, uniform cross –section with a tolerance of ± 1/8 inch per 4 inch width, uniform thickness, and reasonably square ends;

3. Skip lines between 10 and 10-1/2 feet;

4. A gap of 20 feet between stripes; and

5. Beads uniformly.

C. Removal Requirements: Use equipment that:

1. Is maintained in good working condition;

2. Is capable using a commercial abrasive blasting medium;

3. Removes all contaminants from the blasting air;

4. Uses moisture and oil traps; and

5. Seal coat equipment meets requirements of Subsections 4.16, “Seal Coat” and 4.25, “Equipment for Hot-Mix Asphalt Concrete.”

IV. Construction Methods

A. Placement of Work Zone Markings: Install marking before pavement is opened to traffic. Maintain traffic control devices until markings are installed.

Temporary tabs can be placed for 14 days before permanent stripping is placed, the contractor is responsible for maintain tabs during this time period. Place tabs in alignment with final striping. Remove tabs before placement of final striping.

Place markings no sooner than 3 calendar days after placement of a surface treatment.

Place thermo plastic markings to a minimum thickness of 0.060 inches (60 mils). When paint and beads are used, apply at a minimum dry thickness of 0.012 inches (12 mils).

B. Placement of Permanent Markings: Type I markings need to be applied at 0.090 inches (90 mils), but not thicker than 0.180 inches (180 mils). Measure thickness of markings in accordance with Tex-854-B using the tape method. Type II markings need to be placed at 20 gallons per mile on concrete and asphalt surfaces a minimum of 22 gallons for seal coats. Type B prefabricated cannot be place between September 30 and March 1, unless otherwise directed. Apply markings:

1. That meet the requirements of Tex-828-B;

2. That meet minimum retroreflectivity requirements when specified on the plans (applies only to Type 1 markings only);

3. In proper alignment with guides without deviating from the alignment more than 1 inch per 200 feet of roadway;

4. With 40% to 60% of bead embedment;

5. Free of blisters;

6. With uniform cross-section, density, and thickness;

7. Using personnel skilled and experienced with installation of pavement markings;

8. On dry surface, with air temperature of 50°F, for Type I and Type 2;

9. On dry surface, with surface temperature between 60˚F and 120˚F; and

10. That are in accordance with the color, length, shape and configuration

shown on the plans**.**

C. Performance Requirements: Ensure that markings do not lift, shift, smear, spread, flow or tear by traffic action. Markings appear neat, uniform, proper color, and free from ragged edges, irregular lines. Ensure that Type I and II pavement markings are visible from a distance or 300 feet during daytime and at least 160 feet at night when illuminated by automobile low-beam headlights. Remove and replace stripe that does meet these conditions.

D. Surface Preparation: Air blast or broom pavement to remove loose material. For prefabricated markings after cleaning apply sealer or primer as recommended by manufacturer.

E. Removal: Eliminate existing pavement markings on both concrete and asphaltic surfaces in such a manner that color and texture contrast of the pavement surface is held to minimum. Remove all markings with minimal damage to the roadway surface. Any damage to the roadway deeper than ¼ inch will have to be repaired. Use one of the following methods:

1. Blasting Method: Use a blasting method such as water blasting, abrasive blasting, water abrasive blasting or shot blasting. Remove markings on concrete surfaces by using blasting method.

2. Mechanical Method: Use any mechanical method except grinding.

V. Measurement

Construction pavement markings Type I and Type II will be measured by the linear foot of marking placed for the width shown on the plans. Prefabricated pavement markings will be measured for by the foot or by each word, shape, or symbol. Elimination of existing pavement markings will be measured by each word, symbol, shape, or linear foot of stripe removed.

This is a plans quantity measurement item. The quantity is to be paid is the quantity shown is the plans unless modified by Article 10.1.1, “Changes Orders in the Uniform General Conditions for City of Amarillo Civil Construction Contracts.”

VI. Payment

The work performed and materials furnished as prescribed by this subsection, measured as provided under "Measurement", shall be paid for at the unit price bid for "Construction Pavement Markings" of the various sizes, shapes, and colors as specified, which price shall be full compensation for furnishing all materials, labor, tools, equipment and incidentals necessary to place, maintain, and remove the markings as required.

LAST PAGE OF THIS SUBSECTION

Subsection 4.21
Brick Paving and Repair

I. Scope: This Subsection shall govern the removal, cleaning, storing, and relaying brick for streets.

II. Materials

A. Sand: Fine aggregate for bedding and joints shall meet the requirements of Subsection 4.08.II.E, "Fine Aggregates."

B. Cement: Portland cement shall be Type II conforming to the requirements of ASTM C150***.***

C. Concrete*:* Concrete shall conform to 4000 psi concrete detailed in Subsection 4.08, "Concrete."

D. Bricks: Existing brick shall be salvaged, cleaned and reused whenever possible. Reusable brick shall have no more than 2 broken corners and be at least 6 inches in length. The ODR's representative shall approve for reuse all salvaged brick. Additional brick necessary to complete the project may be obtained from the City of Amarillo at North Echo Street and Hazell Avenue. The Contractor is responsible for cleaning all bricks, including those supplied by the City. The contractor is responsible transporting the bricks supplied the City and shall return all unused bricks.

III. Equipment: The Contractor shall supply all equipment required to remove and replace bricks.

IV. Construction Methods

A. Brick Removal*:* The contractor shall remove existing brick in a manner that assures the least amount of damage to the brick. Removal methods must be approved by the ODR. Motor graders, backhoes, front end loaders, other large equipment will not be allowed to remove or handle bricks. Bricks shall not be thrown, tossed, or dropped during handling. Existing concrete damaged during removal shall be replaced by the Contractor.

B. Cleaning Brick: Bricks shall be evaluated by the City Project Representative upon removal, reusable brick shall be stacked. Brick deemed unsalvageable will be disposed of by the Contractor. Bricks designated for reuse shall be cleaned so they are free of paint, oil, asphalt and other foreign matter. Sandblasting of the brick will not be permitted. The cleaning method shall be approved by the ODR.

C. Storage of Bricks: Cleaned brick shall be stored by the Contractor until reused. The Contractor shall be responsible for protecting bricks from damage and theft. Excess

brick shall be delivered and stacked at a designated location.

D. Concrete Base: A concrete base shall be placed as detailed in the plans. Subgrade will be compacted to the density of surrounding material. The surface of the concrete shall receive a rough textured broom finish. The concrete surface shall be placed to the lines and grades shown in the plans. The finished surface shall not vary more than ¼ inch when measured along the length of a 16 foot long straight edge lain in any direction on the surface. Concrete shall be given proper curing at outlined in Subsection 4.11, "Structural Concrete." Concrete base shall be given 48 hours before bricks are placed.

E. Relaying of Bricks: Bedding sand shall be placed on the concrete at the depth shown on the plans. Sand shall have a uniform moisture content of 3% to 7% and compacted. Sand bedding shall be screeded to a uniform thickness and profile such that when bricks are placed and compacted they conform to the lines and grades shown in the plans.

Bricks shall be placed in the same pattern as existed before removal. Placement shall begin immediately after compacting and screeding the sand bedding. The pattern will be maintained true by compressing with an edge board and hammer or other approved method at a minimum interval of every 10 rows. Joints shall be tight and gaps shall not exceed ¼ inch.

Bricks shall be compacted on the bedding sand using a high frequency, low amplitude, flat plate mechanical vibrator. All brick placed in a day shall be compacted in-place the same day. Compacting operations will follow placement as closely as possible, but not closer than 3 feet from laying edge. Brick damaged during placement or compaction shall be removed and replaced.

After compaction, joint sand mixed uniformly with 6 parts sand and 1 part cement and shall be spread onto the brick surface and vibrated into joints through repeated vibratory passes and brushing across the surface. This process may require repeated applications to completely fill all joints. Excess joint sand shall be swept off and removed from the surface.

V. Measurement: Completed and accepted brick street with be measured by the square yard. Work subsidiary to Subsection 4.01, "Utility Construction in City of Amarillo Right of Way and Easements" will not be paid for under this item, but shall be considered subsidiary to that subsection.

VI. Payment: The work performed and materials furnished as prescribed by this subsection and measured as provided will be paid for at the unit bid. The prices shall be full compensation for preparing the subgrade, placing concrete base, placing bedding sand and installing brick complete in place. All materials, manipulation, labor tools, equipment, and incidentals necessary to complete the work will be included in this price.

END OF THIS SUBSECTION

Subsection 4.22
Microsurfacing

I. Scope: The Contractor will furnish and place a microsurfacing system consisting of a mixture of cationic polymer-modified asphalt emulsion, mineral aggregate, mineral filler, water, and other additives.

II. Materials: Furnish uncontaminated materials of uniform quality that meet the requirements of the plans and specifications. Notify the ODR of all materials sources and before changing and material source for formulation. The Contractor will verify that the specification requirements are met when the source or formulation change, and may require a new laboratory mixture design, trial batch, or both. The ODR may sample and test project materials at any time during the project to verify specification compliance.

A. Cationic Polymer-Modified Asphalt Emulsion: Provide CSS-1P in accordance with Subsection 4.23.II.E, "Emulsified Asphalt."

B. Aggregates: The contractor will provide a crushed aggregate from a single source meeting the requirements of Table 1 and Table 2. Determine aggregate gradations for mixture design and production testing based on the washed sieve analysis given in Tex-200-F, Part II. Aggregate from sources listed in TxDOT's *Bituminous Rated Source Quality Catalog* (BRSQC) are preapproved for use. Do not combine approved material with unapproved material. Include the amount of mineral filler added to the mix in determining the total minus No. 200 aggregate fraction.

For sources not listed in TxDOT's BRSQC:

a) Build an individual stockpile for each material

b) Provide test results on the stockpile for specification compliance; and

c) Once approved, do not add material to the stockpile unless otherwise approved.

Table 1
Aggregate Gradation Requirements
Tex-200-F, Part II (Washed)

Sieve Size	Cumulative % Passing
3/8 in.	100.0
#4	86.0-94.0
#8	45.0-65.0
#16	25.0-46.0
#30	15.0-35.0
#50	10.0-25.0
#100	7.0-18.0
#200	5.0-15.0

Table 2
Aggregate Quality Requirements

Property	Test Method	Require-ments
Surface Aggregate Classification	Tex-499A	A
Magnesium sulfate soundness, %, max.[1]	Tex-411-A	25
Crushed face count,[2] %Min	Tex-460-A Part II	95
Sand equivalent value, %, min.	Tex-203-F	70
Acid insoluble, (%), Max	Tex-612-J	55

[1]Use design gradation for the soundness test.
[2]Only applies to crushed gravel

C. Mineral Filler: Provide mineral filler that is free of lumps and foreign matter consisting of non-air-entrained cement meeting the requirements of DMS-4600, "Hydraulic Cement," or hydrated lime meeting the requirements of DMS-6350, "Lime and Lime Slurry."

D. Water: Water usage shall conform to Subsection 3.04 "Requirements for Water Usage."

E. Other Additives: Use approved additives as recommended by the emulsion manufacturer in the emulsion mix or in any of the component materials when necessary to adjust mix time in the field.

F. Tack Coat: Furnish CSS-1H or SS-1H for tack coast binder in accordance with Section 4.23 "Asphalts, Oils, and Emulsions." Do not dilute emulsified asphalts at the terminal, in the field, or at any other location before use.

III. Equipment: Maintain equipment in good repair and operating condition.

A. Mixing Machine. Calibrate and properly mark each control device that proportions the individual materials. Equip the aggregate feed with a revolution counter or similar device capable of determining the quantity of aggregate used at all times. Provide a positive-displacement-type emulsion pump with a

revolution counter or similar device capable of determining the quantity of emulsion used at all times. Provide and approved mineral filler feeding system capable of uniformly and accurately metering the required material. Furnish a self propelled microsurfacing mixing machine with:

1. Self-loading devices to promote continuous laying operations;

2. Enough storage capacity for mixture materials;

3. Individual volume or weight controls that will proportion each material to be added to the mix;

4. Continuous flowing mixing with a revolving multi-blade mixer capable of discharging the mixture on a continuous flow basis;

5. Opposite side driving stations;

6. Full hydrostatic control of the forward and reverse speed during operation;

7. A water pressure system and nozzle-type spray bar immediately ahead of the spreader box and capable of spraying the roadway for the width of the spreader box;

8. A mechanical-type spreader box equipped with paddles or other devices capable of agitating and spreading the materials throughout the box;

9. A spreader box with devices capable of providing lateral movement or side shift abilities; and

10. A spreader box with a front seat, adjustable rear strike-off, and an adjustable secondary rear strike-off.

B. Scales: Scales used for weighing aggregates and emulsion must meet all requirements of Subsection 4.26 "Weighing and Measuring Equipment." The weighing equipment for aggregates may be either a suspended hopper or a belt scale.

C. Asphalt Storage and Handling Equipment: Furnish a thermometer in each tank to indicate the asphalt temperature when continuously storage tanks are used. Keep equipment clean of and free of leaks. Keep asphalt materials free from contamination.

IV. Construction: Produce, transport, and place microsurfacing as specified in this Subsection. Provide emulsion and aggregate that are compatible so that the mixing process will completely and uniformly coat the aggregate. Ensure that the finished surface has a uniform texture and the microsurface mat is fully adhered to the underlying pavement. The ODR may perform production tests at any time during the project. Schedule and participate in a pre-paving meeting with the ODR on or before the first day of paving.

A. Mixture Design: Provide a mixture design meeting the proportions shown in Table 3 and the requirements shown in Table 4. The contractor will ensure the mixture design meets the minimum requirements for wet track abrasion wear value listed in Table 4. The ODR may accept an existing mixture design used on a previous project, but the mixture design may be subjected to annual verification using laboratory-produced mixes before starting the paving season.

Table 3
JMF Proportions

Material	Proportion
Residual asphalt	6.0 to 9.0% by wt. of dry aggregate
Mineral filler (hydraulic cement or hydrated lime)	0.5 to 3.0% by wt. of dry aggregate
Field control additive	As required to provide control of break and cure
Water	As required to provide proper consistency

Table 4
JMF Requirements

Property	Test Method	Require-ments
Wet track abrasion, g/sq. ft., max. wear value	Tex-240-F, Part IV	75
Gradation (aggregate and mineral filler)	Tex-200-F, Part II (Washed)	Table 1
Mix time, controlled to 120 sec.	Tex-240-F, Part I	Pass
Lateral displacement Specific gravity after 1,000 cycles of 125 lb	ISSA TB-147	5% Max 2.10 Max
Excessive asphalt by LWT Sand Adhesion	ISSA TB-109	50 g/ft2

B. Reporting, Testing, and Responsibilities: Submit a report to record and calculate all test data pertaining to production testing. The contractor will immediately report to the ODR any test results that fail to meet the specification requirements. Note that mix placed after test results are available from the Contractor may be considered unauthorized work if the results require suspension of operations. Unauthorized work will be accepted or rejected at the discretion of the ODR.

C. Temporary Material Storage.

1. **Aggregate Storage**: Stockpile materials to prevent segregation or contamination. Remix stockpiles with suitable equipment when necessary to eliminate segregation. Use a scalping screen to remove oversize material while transferring aggregates to the mixing machine.

2. **Mineral Filler Storage:** Store the mineral filler in a manner that will keep it dry and free from contamination.

3. **Asphalt Material Storage:** Keep asphalt materials free from contamination.

D. Weather Limitations: The Contractor may pave any time the roadway has no standing water on the roadway surface, the roadway surface temperature is at least 60°F and the ambient temperature is at least 50°F and rising. Place mixtures only when the ODR determines the roadway surface weather and moisture conditions are suitable. The ODR may restrict the Contractor from paving if the ambient temperature is below 60°F and falling. Cease placement 24 hr. before the weather forecast (National Weather Service) predict temperatures below 32°F unless otherwise approved.

E. Surface Preparation: 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. Provide a water spray immediately ahead of the spreader box when required for existing surface conditions when tack coat is not required. Apply water at a rate that will dampen the entire surface without any free-flowing water ahead of the spreader box.

The contractor is required to mark existing stripe with flexible tabs before paving begins. These tabs will remain in place after paving is completed. Partial tabs are acceptable. Flexible tabs shall meet the requirements outlined in Subsection 4.19 Construction Pavement Marking.

F. Tack Coat: Apply tack coat if required, uniformly at the rate of between 0.04 and 0.10 gal. of residual asphalt per square yard of surface area. Apply tack coat in a uniform manner to avoid streaks and other irregular patterns.

G. Material Transfer: Minimize construction joints by providing continuous loading of material while placing microsurfacing. Ensure that oversized material has been removed prior to transferring the aggregates to the mixing machine.

H. Placing: Make necessary adjustments so that the mixture will have sufficient working life to allow for proper placement at the predicted ambient temperature and humidity. Spread the mixture uniformly to the lines and grades shown on the plans or as directed by means of a mechanical type spreader box. Shift the spreader box when necessary to maintain proper alignment. Clean the spreader box regularly to prevent build up from occurring and to minimize clumps. Set and maintain the spreader box skids to prevent chatter in the finished mat. Prevent loss of material from the spreader box by maintaining contact between the front seal and the road surface. Adjust the rear seal to provide the desired spread. Adjust the secondary strike-off to provide the desired surface texture. Clean strike-off regularly to prevent build up for occurring.

1. Placement requirements

a) At no time will a street be completely closed.

b) Only 2 streets can be under construction at any given tim.

c) Before placing surfacing begins on a street, the Contractor's Superintendent and the City Engineering Project Representative shall review the street for conflicts with access routes to and from emergency services, buildings and parking garages. The Contractor may be required to distribute information concerning closings of driveways and alternative access routes before beginning work on any one street.

d) The Contractor shall maintain access to all facilities during construction. Streets that serve restaurants may receive special scheduling to reduce traffic conflicts during high volume periods such as, but not limited to, lunch periods.

e) No work shall be allowed within school zones while school is in session.

I. Curing: Protect the finished mat from traffic until the mix cures and will not be damaged by traffic. Adjust mixture properties according to humidity conditions and ambient air temperatures to allow uniformly moving traffic on completed travel lanes within 1 hour after placement with no damage to the surface. Protect other locations subject to sharp turning or stopping and starting traffic for longer periods when necessary.

J. Production Testing: Control the production process within the operational tolerances listed in Table 5. Suspend production when the Contractor's test results exceed the operational tolerances. The ODR will allow production to resume when test results or other information indicate the next mixture produced will be within the operational tolerances listed in Table 5. The asphalt content may be reduced below the tolerance shown in Table 5, when lean mixes are necessary for scratch and rut passes but not less than the design minimum shown for the wet track abrasion test when approved.

Table 5
Production Test

Property	Test Method	Requirements
Asphalt content, % by wt.	Tex-236-F[1] or asphalt meter readings	Design target ±0.5% and within limits of Table 1
Gradation, % retained	Tex-200-F, Part II (washed)[1]	#8 sieve and larger: ±5% from design gradation. #16 sieve and smaller: ±3% from design gradation.[2]

[1]Dried to constant wt. at 230°F ±10°F.
[2]Material passing #200 sieve including the mineral filler must conform to the limitations of the master gradation shown in Table 1.

K. Workmanship: Immediately take corrective action if microsurfacing material is exhibiting evidence of poor workmanship, delayed opening to traffic, or surface irregularities, including excessive scratch marks, drag marks, tears, streaks, raveling, delamination, and segregation. The ODR may allow placement to continue for no more than one day of production while taking appropriate action. Suspend paving if the problem still exists after one day until the problem is corrected to the satisfaction of the ODR.

1. **Finished Surface:** Provide a finished surface that has a uniform texture free from excessive scratch marks, tears, or other surface irregularities. Marks, tears, or irregularities are considered excessive if:
   - **a)** More than 1 is at least 1/4 inch wide and at least 10 feet long in any 100 foot of machine pull,
   - **b)** more than 3 are at least 1/2 inch wide and more than 6 inches long in any 100 foot of machine pull, or
   - **c)** Any are 1 inch wide or wider and more than 4 inches in length.

2. **Construction Joints:** Place mixture so that longitudinal joints coincide with on lane lines. Provide longitudinal and transverse joints that are uniform and neat in appearance. Provide construction joints that have limited buildup and that have no gaps between applications. Joints with buildup will be considered acceptable if:
   - **a)** No more than 1/2 inch vertical space exists between the pavement surface and a 4-foot straightedge placed perpendicular to the longitudinal joint and
   - **b)** No more than 1/4 inch vertical space exists between the pavement surface and a 4-foot straightedge placed perpendicular to the transverse joint.

3. **Edges:** Provide an edge along the roadway centerline, lane lines, shoulder, edge of pavement, or curb line that is uniform and neat in appearance. The edge is considered acceptable when:
   - **a)** It varies no more than ±3 inches from a 100-foot straight line on a tangent section and
   - **b)** It varies no more than ±3 inches from a 100-foot arc on a curved section.

L. Miscellaneous Areas: Use a single-batch-type lay-down machine or other approved method to place materials on ramps or other short sections. Apply tack coat or lightly dampen the surface before placing the mix when tack coat is not required. Provide 100% coverage that is uniform in appearance and comparable to that produced by the spreader box.

M. Ruts: Fill ruts, utility cuts, and depressions in the existing surface in a separate pass from the final surface. Cure each lift 24 hours before placement of the next lift when using multiple placements. Fill ruts as follows:

1. Fill irregular or shallow ruts less than 1/2 inch deep with a full-width scratch coat pass. Use a rigid primary strike-off plate.

2. Fill ruts 1/2 inch deep or deeper independently using a rut-filling spreader box that is at least 5 foot wide. Crown the spreader box to compensate for traffic compaction.

3. Fill ruts deeper than 1-1/2 inches in multiple placements.

V. Measurement: Microsurfacing will be measured by the square yard or ton of the composite microsurfacing mixture. The composite microsurfacing mixture is defined as the asphalt emulsion, aggregate, and mineral filler.

A. Aggregate: The quantity of aggregate used in the accepted portion of work will be measured by net ticket weight of each individual load of aggregate based on dry weight of aggregate. Weigh the aggregate at the project stockpile site. Use either a suspended hopper scale or a belt scale meeting the requirements of Subsection 4.21, "Weighing and Measuring Equipment." The calculated weight of mineral filler based on the accepted portion of work will be used for measurement and included in the total aggregate weight.

B. Polymer-Modified Asphalt Emulsion: The quantity of polymer-modified asphalt emulsion in the accepted portion of work will be measured by the ton of material based on the accepted load tickets issued from the manufacturer. At the completion of the project, any unused emulsion will be weighed back and deducted from the accepted asphalt emulsion quantity delivered**.**

VI. Payment: The work performed and materials furnished in accordance with this Subsection and measured as provided under "Measurement" will be paid for at the unit price bid per square yard or ton for "Microsurfacing." This price is full compensation for preparing the existing surface (including removing existing raised pavement markers and placing tabs); furnishing, hauling, preparing, and placing materials; and equipment, labor, tools, and incidentals.

LAST PAGE OF SECTION

Subsection 4.23
Asphalts, Oils, and Emulsions

I. Scope: Provide asphalt cements, cutback and emulsified asphalts, performance-graded asphalt binders, and other miscellaneous asphalt materials as specified on the plans.

II. Materials: Provide asphalt materials that meet the stated requirements when tested in accordance with the referenced TxDOT, AASHTO, and ASTM test methods. Provide asphalt materials that have been preapproved for use by TxDOT's Construction Division in accordance with Tex-545-C, "Asphalt Binder Quality Program."

A. Acronyms used in this Item are defined in Table 1.

Table 1
Acronyms

Acronyms	Definition
Test Procedure Designations	
Tex	Texas Department of Transportation
T or R	AASHTO
D	ASTM
Polymer Modifier Designations	
P	Polymer-modified
SBR or L	Styrene-butadiene rubber (latex)
SBS	Styrene-butadiene-styrene block co-polymer
TR	Tire rubber (ground tire rubber)
AC	Asphalt cement
AE	Asphalt emulsion
AE-P	Asphalt emulsion prime
A-R	Asphalt-rubber
C	Cationic
EAP&T	Emulsified asphalt prime and tack
h-suffix	Emulsified residue
HF	High float
MC	Medium curing
MS	Medium setting
PCE	Prime, cure, and erosion control
PG	Performance grade
RC	Rapid curing
RS	Rapid setting
S-suffix	Stockpile usage
SCM	Special cutback material
SS	Slow-setting

B. Asphalt Cement: Asphalt cement must be homogeneous, water-free, and nonfoaming when heated to 347°F, and must meet Table 2 requirements.

Table2
Asphalt Cement

Property	**Test Procedure**	**AC-0.6**		**AC-1.5**		**AC-3**		**AC-5**		**AC-10**	
		Min	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**
Viscosity	T 202										
140˚F, poise		40	80	100	200	250	350	400	600	800	1200
275˚F, poise		0.4	-	0.7	-	1.1	-	1.4	-	1.9	-
Penetration, 77˚F, 100g, 5 sec.	T49	350	-	250	-	210	-	135	-	85	-
Flash point, C.O.C., ˚F	T48	425	-	425	-	425	-	425	-	450	-
Solubility in Trichloroethylene, %	T44	99.0	-	99.0	-	99.0	-	99.0	-	99.0	-
Spot Test	Tex-509-C	Negative									
Tests on RTFOT: Viscosity 140° poise	T179										
Ductility[1], 77˚F 5 cm/min., cm	T202	-	180	-	450	-	900	-	1500	-	3000
	T51	100	-	100	-	100	-	100	-	100	-

[1] If AC-0.6 or AC-1.5 ductility at 77˚F is less than 100 cm, material is acceptable if ductility at 60˚F is more than 100 cm.

C. Polymer-Modified Asphalt Cement: Polymer-modified asphalt cement must be smooth and homogeneous, and comply with the requirements of Table 3. If requested, supply samples of the base asphalt cement and polymer additives.

Table 3
Polymer-Modified Asphalt Cement

Property	Test Procedure	Polymer-Modified Viscosity Grade											
		AC-5 w/ 2% SBR		AC-10 w/ 2% SBR		AC15-P		AC-20XP		AC-10-2TR		AC-20-5TR	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Polymer		SBR		SBR		SBS		SBS		TR		TR	
Polymer Content % solids basis	Tex-533-C	2.0	-	2.0	-	3.0	-	-	-	2.0	-	5.0	-
Dynamic shear, G*/sin δ, 64˚C, 10 rad/s, kPa	T 315	-	-	-	-	-	-	1.0	-	-	-	1.0	-
Dynamic shear, G*/sin δ, 58˚C, 10 rad/s, kPa	T 315	-	-	-	-	-	-	-	-	1.0	-	-	-
Viscosity 140˚F, Poise 275˚F poise	 T 202 T 202	 700 -	 - 7.0	 1300 -	 - 8.0	 1500 -	 - 8.0	 2000 -	 - -	 1000 -	 - 8.0	 2000 -	 - 10.0
Penetration, 77˚F, 100g, 5 sec.	T 49	120	-	80	-	100	150	75	115	95	130	75	115
Ductility, 5cm/min.,39.2˚F, cm	T 51	70	60	-	-	-	-	-	-	-	-	-	-
Elastic Recovery, 50˚F, %	Tex-539-C	-	-	-	-	55	-	55	-	30	-	55	-
Softening point, ˚F	T 53	-	-	-	-	-	-	120	-	110	-	120	-
Polymer separation, 48 hr.	Tex-540-C	None		None		None		None		None		None	
Flash point, C.O.C., ˚F	T 48	425	-	425	-	425	-	425	-	425	-	425	-
Test on residue from RTFOT aging and pressure aging: Creep Stiffness S,-18˚C, MPa m-value, -18˚C	Tex-541-C and R 28, T 313	 - -	 - -	 - -	 - -	 - 0.30	 300 -	 - 0.30	 300 -	 - 0.30	 300 -	 - 0.30	 300 -

D. Cutback Asphalt: Cutback asphalt must meet the requirements of Tables 4, 5, and 6 for the specified type and grade. If requested, supply samples of the base asphalt cement and polymer additives.

Table 4
Rapid-Curing Cutback Asphalt

Property	Test Procedure	Type-Grade					
		RC-250		RC-800		RC-3000	
		Min	Max	Min	Max	Min	Max
Kinematic viscosity, 140˚F, cSt	T 201	250	400	800	1600	3000	6000
Water, %	D 95	-	0.2	-	0.2	-	0.2
Flash Point, T.O.C., ˚F	T 79	80	-	80	-	80	-
Distillation test:	T 78						
Distillate, % by volume of total Distillate to 680˚F							
to 437˚F		40	75	35	70	20	55
to 500˚F		65	90	55	85	45	75
to 600˚F		85	-	80	-	70	-
Residue from distillation, volume%		70	-	75	-	82	-
Tests on distillation residue:							
Viscosity, 140˚F poise	T 202	600	2400	600	2400	600	2400
Ductility, 5cm/min., 77˚F, cm	T 51	100	-	100	-	100	-
Solubility in trichloroethylene, %	T 44	99.0	-	99.0	-	99.0	-
Spot test	Tex-509-C	Negative		Negative		Negative	

Table 5
Medium-Curing Cutback Asphalt

Property	Test Procedure	Type-Grade							
		MC-30		MC-250		MC-800		MC-3000	
		Min	Max	Min	Max	Min	Max	Min	Max
Kinematic viscosity, 140˚F, cSt	T 201	30	60	250	500	800	1600	3000	6000
Water, %	D 95	-	0.2	-	0.2	-	0.2	-	0.2
Flash Point, T.O.C., ˚F	T 79	95	-	122	-	140	-	149	-
Distillation test:	T 78								
Distillate, % by volume of total Distillate to 680˚F									
to 437˚F		-	35	-	20	-	-	-	-
to 500˚F		30	75	5	55	-	40	-	15
to 600˚F		75	95	60	90	45	85	15	75
Residue from distillation, volume%		50	-	67	-	75	-	80	-
Tests on distillation residue:									
Viscosity, 140˚F poise	T 202	300	1200	300	1200	300	1200	300	1200
Ductility, 5cm/min., 77˚F, cm	T 51	100	-	100	-	100	-	100	-
Solubility in trichloroethylene, %	T 44	99.0	-	99.0	-	99.0	-	99.0	-
Spot test	Tex-509-C	Negative		Negative		Negative		Negative	

Table 6
Special-Use Cutback Asphalt

Property	Test Procedure	Type-Grade					
		MC-2400L		SCM I		SCM II	
		Min	Max	Min	Max	Min	Max
Kinematic viscosity, 140˚F, cSt	T 201	2400	4800	500	1000	1000	2000
Water, %	D 95	-	0.2	-	0.2	-	0.2
Flash Point, T.O.C., ˚F	T 79	150	-	175	-	175	-
Distillation test:	T 78						
Distillate, % by volume of total Distillate to 680˚F							
to 437˚F		-	-	-	-	-	-
to 500˚F		-	35	-	0.5	-	0.5
to 600˚F		35	80	20	60	15	50
Residue from distillation, volume%		78	-	76	-	82	-
Tests on distillation residue:							
Polymer		SBR	SBR	-	-	-	-
Polymer content, % solids basis	Tex-533-C	2.0	-	-	-	-	-
Penetration, 100 g 5 sec., 77˚F	T 49	150	300	180	-	180	-
Ductility, 5cm/min., 39.2˚F, cm	T 50	50	-	-	-	-	-
Solubility in trichloroethylene, %	T 44	99.0	-	99.0	-	99.0	-

E. Emulsified Asphalt: Emulsified asphalt must be homogeneous, not separate after thorough mixing, and meet the requirements for the specified type and grade in Tables 7, 8, 9, and 10.

Table 7
Emulsified Asphalt

Property	Test Procedure	Type-Grade									
		Rapid-Setting		Medium Setting				Slow Setting			
		HFRS-2		MS-2		AES-300		SS-1		SS-1H	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Viscosity, Saybolt Furol	T 72										
77˚F, sec.		-	-	-	-	75	400	20	100	20	100
122˚F, sec.		150	400	100	300	-	-	-	-	-	-
Sieve test, %	T 59	-	0.1	-	0.1	-	0.1	-	0.1	-	0.1
Miscibility	T 59	-		-		-		Pass		Pass	
Cement Mixing, %	T 59	-	-	-	-	-	-	-	2.0	-	2.0
Coating ability and water resistance:	T 59										
Dry aggregate/ after spray		-		-		Good /Fair		-		-	
Wet aggregate/ after spray		-		-		Fair /Fair		-		-	
Demulsibilty, 35 ml of 0.02 N $CaCl_2$, %	T 59	50	-	-	30	-	-	-	-	-	-
Storage stability, 1 day, %	T 59	-	1	-	1	-	1	-	1	-	1
Freezing Test, 3 cycles[1]	T 59	-		Pass		-		Pass		Pass	
Distillation test:	T 59										
Residue by distillation, % By weight		65	-	65	-	65	-	60	-	60	-
Oil distillate, % by volume Of emulsion		-	0.5	-	0.5	-	5	-	0.5	-	0.5
Tests on residue from distillation:											
Penetration, 77˚F, 100 g, 5 sec.	T 49	100	140	120	160	300	-	120	160	70	100
Solubility in	T 44	97.5	-	97.5	-	97.5	-	97.5	-	97.5	-
trichloroethylene, %	T 51	100	-	100	-	-	-	100	-	80	-
Ductility, 77˚F 5 cm/min., cm	T 50	1200	-	-	-	1200	-	-	-	-	-
Float test, 140˚F, sec											

[1] Applies only when the Engineer or ODR designates for winter use.

Table 8
Cationic Emulsified Asphalt

Property	Test Procedure	Type-Grade											
		Rapid-Setting				Medium-Setting				Slow-Setting			
		CRS-2		CRS-2H		CMS-2		CMS-2S		CSS-1		CSS-1H	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Viscosity, Saybolt Furol 77˚F, sec. 122˚F, sec	T 72	- 150	- 400	- 150	- 400	- 100	- 300	- 100	- 300	20 -	100 -	20 -	100 -
Sieve test, %	T 59	-	0.1	-	0.1	-	0.1	-	0.1	-	0.1	-	0.1
Cement mixing, %	T 59	-	-	-	-	-	-	-	-	-	2.0	-	2.0
Coating ability and water resistance: Dry aggregate/after spray Wet aggregate/after spray	T 59	- -		- -		Good/ Fair Fair/ Fair		Good/ Fair Fair/ Fair		- -		- -	
Demulsibility, 35 ml of 0.8% Sodium dioctyl sulfosuccinate, %	T 59	70	-	70	-	-	-	-	-	-	-	-	-
Storage stability, 1 day %	T 59	-	1	-	1	-	1	-	1	-	1	-	1
Particle charge	T 59	Positive		Positive		Positive		Positive		Positive		Positive	
Distillation test: Residue by distillation, % by weight Oil distillate, % by volume of emulsion	T 59	65 -	- 0.5	65 -	- 0.5	65 -	- 7	65 -	- 5	60 -	- 0.5	60 -	- 0.5
Tests on residue from distillation: Penetration, 77˚F, 100g, 5 sec Solubility in trichloroethylene, % Ductility, 77˚F, 5 cm/min., cm	T 49 T 44 T 51	120 97.5 100	160 - -	70 97.5 80	110 - -	120 97.5 100	200 - -	300 97.5 -	- - -	120 97.5 100	160 - -	70 97.5 80	110 - -

Table 9
Polymer-Modified Emulsified Asphalt

Property	Test Procedure	Type-Grade											
		Rapid-Setting				Medium Setting				Slow-Setting			
		RS-1P		HFRS-2P		AES-150P		AES-300P		AES-300S		SS-1P	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Viscosity, Saybolt Furol 77˚F, sec. 122˚F, sec.	T 72	- 150	- 200	- 150	- 400	75 -	400 -	75 -	400 -	75 -	400 -	30 -	100 -
Sieve test, %	T 59	-	0.1	-	0.1	-	0.1	-	0.1	-	0.1	-	0.1
Miscibility	T 59	-		-		-		-		-		Pass	
Coating ability and water resistance: Dry aggregate/after spray Wet aggregate/after spray	T 59	- -		- -		Good/Fair Fair/Fair		Good/Fair Fair/Fair		Good/Fair Fair/Fair		- -	
Demulsibility, 35 ml of 0.02 N CaCl2, &	T 59	60	-	50	-	-	-	-	-	-	-	-	-
Storage stability, 1 day, %	T 59	-	1	-	1	-	1	-	1	-	1	-	1
Breaking index, g	Tex-542-C	-	80	-	-	-	-	-	-	-	-	-	-
Distillation test[1]: Residue by distillation, % by wt. Oil distillate, % by volume of emulsion	T 59	65 -	- 3	65 -	- 0.5	65 -	- 3	65 -	- 5	65 -	- 7	60 -	- 0.5
Tests on residue from distillation: Polymer content, wt. % solids basis Penetration, 77˚F, 100 g, 5 sec Solubility in trichloroethylene, % Viscosity, 140˚F, poise Float test, 140˚F, sec. Ductility[2], 39.2˚F, 5 cm/min., cm Elastic recovery[2], 50˚F, %	Tex-533-C T 49 T 44 T 202 T 50 T 51 Tex-539-C	- 225 97.0 - - - 55	- 300 - - - - -	3.0 90 97.0 150 0 120 0 50 55	- 140 - - - - -	- 150 97.0 - 1200 - -	- 300 - - - - -	- 300 97.0 - 1200 - -	- - - - - - -	- 300 97.0 - 120 0 - -	- - - - - - -	3.0 100 97.0 1300 - 50 -	- 140 - - - - -
Tests on RTFO curing of distillation residue Elastic recovery, 50˚F, %	Tex-541-C Tex-539-C	-	-	-	-	50	-	50	-	30	-	-	-

[1]Exception to T 59: Bring the temperature on the lower thermometer slowly to 350˚F ± 10˚F. Maintain at this temperature for 20 minutes. Complete total distillation in 60 minutes (± 5 minutes) from the first application of heat.
[2] HFRS-2P must meet one of either the docility or elastic recovery requirements.

Table 10
Polymer-Modified Cationic Emulsified Asphalt

Property	Test Procedure	Type-Grade											
		Rapid-Setting						Medium-Setting				Slow-Setting	
		CRS-1P		CRS-2P		CHFRS-2P		CMS-1P[3]		CMS-2P[3]		CSS-1P	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Viscosity, Saybolt Furol 77˚F, sec. 122˚F, sec.	T 72	- 50	- 150	- 150	- 400	- 100	- 400	20 -	100 -	- 50	- 400	20 -	100 -
Sieve test, %	T 59	-	0.1	-	0.1	-	0.1	-	0.1	-	0.1	-	0.1
Demulsibility, 35 ml of 0.8% Sodium dioctyl sulfosuccinate, %	T 59	60	-	70	-	60	-	-	-	-	-	-	-
Storage Stability, 1 day, %	T 59	-	1	-	1	-	1	-	-	-	-	-	1
Breaking index, g	Tex-542-C	-	80	-	-	-	-	-	-	-	-	-	-
Particle Charge	T 59	Positive		Positive		Positive		Positive		Positive		Positive	
Distillation test[1]: Residue by distillation, % by weight Oil distillate, % by volume of emulsion	T 59	65 -	- 3	65 -	- 0.5	65 -	- 0.5	65 -	- 0.5	65 -	- 0.5	62 -	- 0.5
Tests on residue from distillation: Polymer content, wt. % solids basis Penetration, 77˚F, 100 g, 5 sec. Viscosity, 140˚F, poise Solubility in trichloroethylene, % Softening point, ˚F Ductility[2], 39.2˚F, 5 cm/min., cm Float test, 140˚F, sec. Ductility[2], 392.˚F, 5 cm/min., cm Elastic recovery[2], 50˚F, %	Tex-533-C T 49 T 202 T44 T 53 T 51 T 50 T 51 Tex-539-C	- 225 - 97.0 - - - - 45	- 300 - - - - - - -	3.0 90 1300 97.0 - - - - 50 55	- 150 - - - - - - -	3.0 80 1300 95.0 130 - 1800 - 55	- 130 - - - - - - -	- 40 - - - - - - 45	- - 5000 - - - - - -	- 40 - - - - - - 45	- - 5000 - - - - - -	30 55 - 97.0 135 70 - - -	- 90 - - - - - - -
Tests on rejuvenating agent: Viscosity, 140˚F, cSt Flash point, C.O.C.., ˚F Saturates, % by weight Solubility in n-pentane, % by weight	T 201 T 48 D 2007 D 2007	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	50 380 - 99	175 - 30 -	50 380 - 99	175 - 30 -	- - - -	- - - -
Tests on rejuvenating agent after TFO or RTFO: Weight change, % Viscosity ratio	T 240 or T 179	- -	- -	- -	- -	- -	- -	- -	6.5 3.0	- -	6.5 3.0	- -	- -
Tests on latex[4]: Tensile strength, die C dumbbell, psi Change in mass after immersion in rejuvenating agent, %	D 412[5] D 471	- -	- -	- -	- -	- -	- -	500 -	- 40[6]	500 -	- 40[6]	- -	- -

[1]Exception to T 59: Bring the temperature on the lower thermometer slowly to 350˚F. Maintain at this temperature for 20 minutes. Complete total distillation in 60 minutes (±5 minutes) from the first application of heat.
[2]CRS-2P must meet one of either the ductility or elastic recovery requirements.
[3]With all precertification samples of CMS-1P or CMS-2P, submit certified test reports showing that rejuvenating agent and latex meet the stated requirements. Submit samples of these raw materials if requested by the ODR.
[4]Preparation of latex films: Use any substrate which produces a film of uniform cross-section. Apply latex using a drawdown tool that will deliver enough material to achieve desired residual thickness. Cure films for 14 days at 75˚F and 50% relative humidity.
[5]Cut samples for tensile strength determination using a crosshead speed of 20 inches/ minute.
[6]Specimen must remain intact after exposure and removal of excess rejuvenating agent.

F. Specialty Emulsions: Specialty emulsions may be either asphalt-based or resin-based and must meet the requirements of Table 11.

Table 11
Specialty Emulsions

Property	Test Procedure	Type-Grade					
		Medium-Setting				Slow-Setting	
		AE-P		EAP&T		PCE[1]	
		Min	Max	Min	Max	Min	Max
Viscosity, Saybolt Furol	T 72						
77˚F, sec.		-	-	-	-	10	100
122˚F, sec.		15	150	-	-	-	-
Sieve test, %	T 59	-	0.1	-	0.1	-	0.1
Miscibility[2]	T 59	-		Pass		Pass	
Demulsibilty, 35 ml of 0.10 N $CaCl_2$, %	T 59	-	70	-	-	-	-
Storage stability, 1 day, %	T 59	-	1	-	1	-	-
Particle size[5], % by volume <2.5 µm	Tex-238-F[3]	-	-	90	-	90	-
Asphalt emulsion distillation to 500˚F Followed by cutback asphalt distillation of residue to 680˚F:	T 59 & T 78						
Residue after both distillations, % by wt.		40	-	-	-	-	-
Total oil distillate from both distillations, % by volume of emulsion		25	40	-	-	-	-
Residue by distillation, % by wt.	T 59	-	-	60	-	-	-
Residue by evaporation[4], % by wt.	T 59	-	-	-	-	60	-
Tests on residue after all distillations:							
Viscosity, 140˚F, poise	T 202	-	-	800	-	-	-
Kinematic viscosity[5], 140˚F, cSt	T 201	-	-	-	-	100	350
Flash point C.O.C., ˚F	T 48	-	-	-	-	400	-
Solubility in trichloroethylene, %	T 44	97.5	-	-	-	-	-
Float test, 122˚F, sec.	T 50	50	200	-	-	-	-

[1]Supply with each shipment of PCE:

a) A copy of a lab report from an approved analytical lab, signed by a lab official, indicating the PCE formulation does not meet any characteristics of a Resource Conservation Recovery Act (RCRA) hazardous waste;

b) A certification from the producer that the formulation supplied does not differ from the one tested and that no listed RCRA hazardous wastes or PCBs have been mixed with the product; and

c) A Material Safety Data Sheet.

[2]Exception to T 59: In dilution, use 350 ml of distilled or deionized water and a 1,000-ml beaker.

[3]Use Tex-238-F, beginning at "Particle Size Analysis by Laser Diffraction," with distilled or deionized water as a medium and no dispersant, or use another approved method.

[4]Exception to T 59: Leave sample in the oven until foaming ceases, then cool and weigh.

[5]PCE must meet either the kinematic viscosity requirement or the particle size requirement.

G. Recycling Agent: Recycling agent and emulsified recycling agent must meet the requirements in Table 12. Additionally, recycling agent and residue from emulsified recycling agent, when added in the specified proportions to the recycled asphalt, must meet the properties specified on the plans.

Table 12
Recycling Agent and Emulsified Recycling Agent

Property	Test Procedure	Recycling Agent		Emulsified Recycling Agent	
		Min	Max	Min	Max
Viscosity, Saybolt Furol, 77˚F, sec.	T 72	-	-	15	100
Sieve test, %	T 59	-	-	-	0.1
Misibility[1]	T 59	-		No coagulation	
Residue by evaporation[2], % by wt.	T 59	-	-	60	-
Tests on recycling agent or residue from evaporation:	T 48 T 201				
Flash point, C.O.C., ˚F		400	-	400	-
Kinematic viscosity,					
140˚F, cSt		75	200	75	200
275˚F, cSt		-	10.0	-	10.0

[1]Exception to T 59: use 0.02 N $CaCl_2$ solution in place of water
[2]Exception to T 59: Maintain sample at 300˚F until foaming ceases, then cool and weigh.

H. Crumb Rubber Modifier: Crumb rubber modifier (CRM) consists of automobile and truck tires processed by ambient temperature grinding. CRM must be:

1. Free from contaminants including fabric, metal, and mineral and other nonrubber substances;

2. Free-flowing; and

3. Nonfoaming when added to hot asphalt binder.

When tested in accordance with Tex-200-F, Part I, using a 50-g sample, the rubber gradation must meet the requirements of the grades in Table 13.

Table 13
CRM Gradations

Sieve Size	Grade A		Grade B		Grade C		Grade D
% Passing	Min	Max	Min	Max	Min	Max	
#8	100	-	-	-	-	-	As shown on the plans
#10	95	100	100	-	-	-	
#16	-	-	70	100	100	-	
#30	-	-	25	60	90	100	
#40	-	-	-	-	45	100	
#50	0	10	-	-	-	-	
#200	-	-	0	5	-	-	

I. Crack Sealer: Polymer modified asphalt-emulsion crack sealer must meet the requirements of Table 14. Rubber-asphalt crack sealer must meet the requirements of Table 15.

Table 14
Polymer-Modified Asphalt Emulsion Crack Sealer

Property	Test Procedure	Min	Max
Rotational viscosity, 77˚F, cP	D 2196, Method A	10,000	25,000
Sieve test, %	T 59	-	0.1
Storage stability, 1 day, %	T 59	-	1
Evaporation Residue by evaporation, % by wt.	Tex-543-C	 65	 -
Tests on residue from evaporation: Penetration, 77˚F, 100 g, 5 sec. Softening point, ˚F Ductility, 39.2˚F, 5 cm/min., cm	 T 49 T 53 T 51	 35 140 100	 75 - -

Table 15
Rubber-Asphalt Crack Sealer

Property	Test Procedure	Class A		Class B	
		Min	Max	Min	Max
CRM content, Grade A or B, % by wt.	Tex-544-C	22	26	-	-
CRM content, Grade B, % by weight	Tex-544-C	-	-	13	17
Virgin rubber content[1], % by weight		-	-	2	-
Flash point[2], C.O.C., ˚F	T 48	400	-	400	-
Penetration[3], 77˚F, 150 g, 5 sec.	T 49	30	50	30	50
Penetration[3], 32˚F, 200 g, 60 sec.	T 49	12	-	12	-
Softening point, ˚F	T 53	-	-	170	-
Bond test, non-immersed, 0.5 in specimen, 50% extension, 20˚F[4]	D 5329	-		Pass	

[1]Provide certification that the minimum % virgin rubber was added.
[2]Agitate the sealing compound with a 3/8 inch to ½ inch wide, square end metal spatula to bring the material on the bottom of the cup to the surface (i.e., turn the material over) before passing the test flame over the cup. Start at one side of the thermometer, move around to the other, and then return to the starting point using 8 to 10 rapid circular strokes. Accomplish agitation in 3 to 4 seconds. Pass the test flame over the cup immediately after stirring is completed.
[3]Exception to T 49: Substitute the cone specified in D 217 for the penetration needle.
[4]Allow no crack in the crack sealing materials or break in the bond between the sealer and the mortar blocks over ¼ inch deep for any specimen after completion of the test.

J. Asphalt-Rubber Binders: Asphalt-rubber (A-R) binders are mixtures of asphalt binder and CRM, which have been reacted at elevated temperatures. The A-R binders meet D 6114 and contain a minimum of 15% CRM by weight. Types I or II, containing CRM Grade C, are used for hot mixed aggregate mixtures. Types II or III, containing CRM Grade B, are used for surface treatment binder. Ensure binder properties meet the requirements of Table 16.

Table 16
A-R Binders

Property	Test Procedure	Binder Type					
		Type I		Type II		Type III	
		Min	Max	Min	Max	Min	Max
Apparent viscosity, 347°F, cP	D 2196, Method A	1500	5000	1500	5000	1500	5000
Penetration, 77°F, 100g, 60 sec.	T 49	25	75	25	75	50	100
Penetration, 39.2°F, 200g, 60 sec.	T 49	10	-	15	-	25	-
Softening point, °F	T 53	135	-	130	-	125	-
Resilience, 77°F, %	D 5329	25	-	20	-	10	-
Flash point, C.O.C., °F	T 48	450	-	450	-	450	-
Test on residue from Thin-Film Oven Test:	T 179						
Retained penetration ratio, 39.2°F, 200 g, 60 sec., % of original	T 49	75	-	75	-	75	-

K. Performance-Graded Binders: PG binders must be smooth and homogeneous, show no separation when tested in accordance with Tex-540-C, and meet Table 17 requirements. Separation testing is not required if:

A. A modifier is introduced separately at the mix plant either by injection in the asphalt line or mixer;

B. The binder is blended on site in continuously agitated tanks; or

C. Binder acceptance is based on field samples taken from an in-line sampling port at the hot mix plant after the addition of modifiers.

Table 17
Performance-Graded Binders

Property	Test Method	Performance Grade							
		PG 58		PG 64		PG 70		PG 76	
		-22	-28	-22	-28	-22	-28	-22	-28
Average 7 day max pavement design temperature, ˚C[1]		< 58		< 64		< 70		< 76	
Min pavement design temperature, ˚C[1]		> -22	> -28	> -22	> -28	> -22	> -28	> -22	> -28
Original Binder									
Flash point, Min, ˚C	T 48	230							
Viscosity[2,3] Max, 3.0 Pa·s, test temperature, ˚C	T 316	135							
Dynamic shear: G*/sin(δ), Min, 1.00 kPa, Max 2.00 kPa,[7] Test temperature @ 10 rad/sec., ˚C	T 315[4]	58		64		70		76	
Elastic recovery, 50˚F, % min	D 6084	-	-	-	30	30	50	50	60
Rolling Thin-Film Oven (Tex-541-C)									
Mass loss, Max %	Tex-541-C	1.0							
Dynamic shear: G*/sin(δ), Min, 2.20 kPa, Max 5.00 kPa,[7] Test temperature @ 10 rad/sec., ˚C	T 315	58		64		70		76	
Pressure Aging Vessel (PAV) Residue (R28)									
PAV aging temperature, ˚C	100								
Dynamic shear: G*/sin(δ), Max 5,000 kPa, Test temperature @ 10 rad/sec., ˚C	T 315	25	22	25	22	25	22	25	22
Creep stiffness[5,6] S, max, 300 MPa m-value, Min 0.300 Test temperature @ 60 sec., ˚C	T 313	-12	-18	-12	-18	-12	-18	-12	-18
Direct tension[6] Failure strain, Min, 1.0% Test temperature @ 1.0 mm/min., ˚C	T 314	-12	-18	-12	-18	-12	-18	-12	-18

[1]Pavement temperatures are estimated from air temperatures using an algorithm contained in a TxDOT computer program, or by following procedures outlined in ASSHTO MP 2 and PP 28.
[2]This requirement may be waived at the City's discretion if the supplier warrants that the asphalt binder can be adequately pumped, mixed, and compacted at temperatures that meet all applicable safety, environmental, and constructability requirements. At test temperatures where the binder is a Newtonian fluid, any suitable standard means of viscosity measurement may be used, including capillary (T 201 or T 202) or rotational viscometry (T 316).
[3]Viscosity at 135˚C is an indicator of mixing and compaction temperatures that can be expected in the lab and field. High values may indicate high mixing and compaction temperatures. Additionally, significant variation can occur from batch to batch. Contractors should be aware that variation could significantly impact their mixing and compaction operations. Contractors are therefore responsible for addressing and constructability issues that may arise.
[4]For quality control of unmodified asphalt binder production, measurement of the viscosity of the original asphalt binder may be substituted for dynamic shear measurements of G*/sin(δ) at test temperatures where the asphalt is a Newtonian fluid. Any suitable standard means of viscosity measurement may be used, including capillary (T 201 or T 202) or rotational viscometry (T 316).
[5]Silicone beam molds, as described in AASHTO TP 1-93, are acceptable for use.
[6]If creep stiffness is below 300 MPa, direct tension test is not required. If creep stiffness is between 300 and 600 MPa, the direct tension failure strain requirement can be used instead of the creep stiffness requirement. The m-value requirement must be satisfied in both cases.
[7]Maximum values for unaged and RTFO aged dynamic shear apply to materials used as substitute binders, as described in Subsection 4.13 "Dense Graded Hot-Mix Asphalt."

III. Equipment: The contractor will provide the required or necessary equipment in accordance with Subsection 4.25, "Equipment for Asphalt Concrete Pavement" and Subsection 4.26 "Weighing and Measuring Equipment."

IV. Construction

A. Seasonal Restrictions: The "open" season for applying asphaltic materials and mixtures for the listed items shall be as follows, unless authorized otherwise in writing by the ODR.

Subsections	Open season
4.16 (Hot Asphalt)	From April 15th through September 30th
4.16 (Cold Weather Asphalt)	No Season
4.17, 4.18, 4.22	From April 15th through October 31st

B. Typical Material Use: Table 18 shows typical materials used for specific applications. These are typical uses only. Circumstances may require use of other material.

Table 18
Typical Material Use

Material Application	Typically Used Materials
Hot-mixed, hot laid asphalt mixtures	PG binders, A-R binders Types I and II
Hot-mixed, cold-laid asphalt mixtures	AC-0.6, AC-1.5, AC-3, AES-300, AES-300P, CMS-2, CMS-2S
Surface treatment	AC-5,AC-10, AC-5 W/2% SBR, AC-10 W/2% SBR, AC-15P, AC-20XP, AC-10-2TR, AC-20-5TR, HFRS-2, MS-2, CRS-2, CRS-2H, HFRS-2P, CRS-2P, CHFRS-2P, A-R binders Types II and III
Surface treatment (cool weather)	RS-1P, CRS-1P, RC-250, RC-800, RC-3000, MC-250, MC-800, MC-3000, MC-2400L
Precoating	AC-5, AC-10, PG-22, SS-1, SS-1H, CSS-1, CSS-1H
Tack coat	PG binders, SS-1H, CSS-1H, EAP&T
Fog seal	SS-1, SS-1H, CSS-1
Recycling	AC-0.6, AC-1.5, AC-3, AES-150P, AES-300P
Crack sealing	SS-1P, rubber asphalt crack sealers (Class A and Class B)
Microsurfacing	CSS-1P
Prime	MC-30, AE-P, EAP&T
Curing membrane	SS-1, SS-1H, CSS-1, CSS-1H
Erosion control	SS-1, SS-1H, CSS-1, CSS-1H

C. Storage and Application Temperatures: Use storage and application temperatures in accordance with Table 19. Store and apply materials at the lowest temperature yielding satisfactory results. Follow the manufacturer's instructions for any agitation requirements in storage. Manufacturer's instructions regarding recommended application and storage temperatures supersede those of Table 19.

Table 19
Storage and Application Temperatures

Type-Grade	Application		Storage Maximum ˚F
	Recommended Range ˚F	Maximum Range ˚F	
AC-0.6, AC-1.5, AC-3	200-300	350	350
AC-5, AC-10	275-350	350	350
AC-5 w/2% SBR, AC-10 w2% SBR, AC-15P, AC-20-5TR	300-375	375	360
RC-250	125-180	200	200
RC-800	170-230	260	260
RC-3000	215-275	285	285
MC-30, AE-P	70-150	175	175
MC-250	125-210	240	240
MC-800, SCM I, SCM II	175-260	275	275
MC-3000, MC-2400L,	225-275	290	290
HFRS-2,MS-2, CRS-2, CRS-2H, HFRS-2P, CRS-2P, CMS-2, CMS-2S, AES-300, AES-300S, AES-150P, AES-300P	120-160	180	180
SS-1, SS-1H, CSS-1, CSS-1H, EAP&T, SS-1P, RS-1P, CRS-1P, CSS-1P, recycling agents	50-130	140	140
PG binders	275-350	350	350
Rubber asphalt crack sealers (Class A and Class B)	350-375	400	-
A-R binders Types I, II, and III	325-425	425	425

V. Measurement and Payment: The work performed, materials furnished, equipment, labor, tools, and incidentals will not be measured or paid for directly, but is subsidiary or is included in payment for other bid Items.

LAST PAGE OF SECTION

Subsection 4.24
Asphalt Antistripping Agents

I. Scope: Furnish and incorporate all required asphalt antistripping agents in asphalt concrete paving mixtures and asphalt-stabilized base mixtures to meet moisture resistance testing requirements.

II. Materials:

A. Lime: Provide hydrated lime or commercial lime slurry in accordance with DMS-6350, "Lime and Lime Slurry."

B. Liquid Antistripping Agent: Provide a liquid antistripping agent that is uniform and shows no evidence of crystallization, settling, or separation. Ensure that all liquid antistripping agents arrive in:

1. Properly labeled and unopened containers, as shipped from the manufacturer, or

Sealed tank trucks with an invoice to show contents and quantities.

2. Provide product information to the ODR including:

3. Material Safety Data Sheet,

4. Specific gravity of the agent at the manufacturer's recommended addition temperature,

5. Manufacturer's recommended dosage range, and

6. Handling and storage instructions.

III. Equipment: Provide all equipment to store, handle, dispense, meter, and mix asphalt antistripping agents.

IV. Construction

A. Laboratory Design Evaluation and Production Mixture Verification: Provide a laboratory mixture design and production mixture that meet moisture resistance requirements. During design and production, evaluate proposed asphalt pavement or base mixtures according to the moisture resistance requirements in the asphalt mixture specification. Governing specifications require the Contractor to design the mixture, and is responsible for the moisture susceptibility evaluation. The ODR or Engineer will verify for compliance. If an antistripping agent is required, determine the dosage needed to achieve the moisture resistance requirements during design. Use this addition rate in the production mixture. When using lime, add between 0.5% and 2.0% of hydrated lime or commercial lime slurry solids by weight of the individual aggregate treated. When using a liquid antistripping agent, add it to the binder in accordance with the manufacturer's instructions and

do not exceed the manufacturer's maximum recommended dosage rate. If the production mixture does not meet moisture resistance requirements, stop production and correct the problem.

B. Addition of Antistrip Agents at the Mix Plant: Connect the measuring device for the addition of the asphalt antistripping agent into the automatic plant controls to automatically adjust the supply to plant production and provide a consistent percentage in the mixture. Set automatic plant controls so that an interruption of asphalt antistripping agent's flow causes plant shutdown.

C. Lime: Incorporate lime in a manner that thoroughly and uniformly distributes lime onto the aggregate surface or into the mixture. Use metering equipment, as approved, to ensure the required quantity of lime is used.

D. Hydrated Lime: Add lime to the aggregate by one of the following methods, unless otherwise shown on the plans:

1. Mix in an approved pug mill mixer with damp aggregate containing water at least 2% above saturated surface dry conditions.

2. Add into the drum-mix plant immediately before asphalt binder addition or in the pug mill of the weigh-batch plant before asphalt binder addition. If a weigh-batch plant is used, dry mix aggregates and lime before adding asphalt binder.

E. Commercial Lime Slurry: Add lime to the aggregate by one of the following methods, unless otherwise shown on the plans:

1. Mix in a suitable pug mill mixer with the aggregate.

2. During mixture production, mix with aggregate between the plant cold feeds and the dryer or mixing drum.

F. Liquid Antistripping Agent: Incorporate into the binder as follows:

1. Handle in accordance with the manufacturer's recommendations.

2. Add at the manufacturer's recommended temperature.

3. Add into the asphalt line by means of an in-line-metering device, in accordance with Subsection 4.26, "Weighing and Measuring Equipment," and a blending device to disperse the agent.

4. Place the metering and blending devices in an approved location.

V. Measurement and Payment: The work performed, materials furnished, equipment, labor, tools, and incidentals will not be measured or paid for directly, but is subsidiary or is included in payment quantity for pertinent Items.

LAST PAGE OF SECTION

SUBSECTION 4.25
EQUIPMENT FOR ASPHALT CONCRETE PAVEMENT

I. Scope: The contractor will provide equipment to produce, haul, place, compact, and core asphalt concrete pavement.

II. Equipment: Ensure weighing and measuring equipment complies with Subsection 4.21, "Weighing and Measuring Equipment." Synchronize equipment to produce a mixture meeting the required proportions.

A. Production Equipment:

1. Drum-mix type, weigh-batch, or modified weigh-batch mixing plants that ensure a uniform, continuous production;

2. automatic proportioning and measuring devices with interlock cut-off circuits that stop operations if the control system malfunctions;

3. visible readouts indicating the weight or volume of asphalt and aggregate proportions;

4. safe and accurate means to take required samples by inspection forces;

5. permanent means to check the output of metering devices and to perform calibration and weight checks; and

6. additive-feed systems to ensure a uniform, continuous material flow in the desired proportion.

B. Drum-Mix Plants: Provide a mixing plant that complies with the requirements below.

1. Aggregate Feed System**.** Provide:

2. a minimum of 1 cold aggregate bin for each stockpile of individual materials used to produce the mix;

3. bins designed to prevent overflow of material;

4. scalping screens or other approved methods to remove any oversized material, roots, or other objectionable materials;

5. a feed system to ensure a uniform, continuous material flow in the desired proportion to the dryer;

6. an integrated means for moisture compensation;

7. belt scales, weigh box, or other approved devices to measure the weight of the combined aggregate; and

8. cold aggregate bin flow indicators that automatically signal interrupted material flow.

C. **Reclaimed Asphalt Pavement (RAP) Feed System:** Provide a separate system to weigh and feed RAP into the hot mix plant.

D. **Mineral Filler Feed System:** Provide a closed system for mineral filler that maintains a constant supply with minimal loss of material through the exhaust system. Interlock the measuring device into the automatic plant controls to automatically adjust the supply of mineral filler to plant production and provide a consistent percentage to the mixture.

E. **Heating, Drying, and Mixing Systems:** Provide:

1. a dryer or mixing system to agitate the aggregate during heating;
2. a heating system that controls the temperature during production to prevent aggregate and asphalt binder damage;
3. a heating system that completely burns fuel and leaves no residue; and
4. a recording thermometer that continuously measures and records the mixture discharge temperature.

F. **Asphalt Binder Equipment:** Supply equipment to heat binder to the required temperature. Equip the heating apparatus with a continuously recording thermometer located at the highest temperature point. Produce a 24-hr. chart of the recorded temperature. Place a device with automatic temperature compensation that accurately meters the binder in the line leading to the mixer.

1. Furnish a sampling port on the line between the storage tank and mixer. Supply an additional sampling port between any additive blending device and mixer.

G. **Mixture Storage and Discharge:** Provide a surge-storage system to minimize interruptions during operations unless otherwise approved. Furnish a gob hopper or other device to minimize segregation in the bin. Provide an automated system that weighs the mixture upon discharge and produces a ticket showing:

1. date,
2. project identification number,
3. plant identification,
4. mix identification,
5. vehicle identification,
6. total weight of the load,

7. tare weight of the vehicle,

8. weight of mixture in each load, and

9. load number or sequential ticket number for the day.

H. Truck Scales: Provide standard platform scales at an approved location.

I. Weigh-Batch Plants: Provide a mixing plant that complies with Subsection 4.20.II.B, "Drum-Mix Plants," except as required below.

1. **Screening and Proportioning:** Provide enough hot bins to separate the aggregate and to control proportioning of the mixture type specified. Supply bins that discard excessive and oversized material through overflow chutes. Provide safe access for inspectors to obtain samples from the hot bins.

2. **Aggregate Weigh Box and Batching Scales:** Provide a weigh box and batching scales to hold and weigh a complete batch of aggregate. Provide an automatic proportioning system with low bin indicators that automatically stop when material level in any bin is not sufficient to complete the batch.

3. **Asphalt Binder Measuring System:** Provide bucket and scales of sufficient capacity to hold and weigh binder for 1 batch.

4. **Mixer:** Equip mixers with an adjustable automatic timer that controls the dry and wet mixing period and locks the discharge doors for the required mixing period. Furnish a pug mill with a mixing chamber large enough to prevent spillage.

J. Modified Weigh-Batch Plants: Provide a mixing plant that complies with Subsection 4.20.II.I, "Weigh-Batch Plants," except as specifically described below.

K. Aggregate Feeds: Aggregate control is required at the cold feeds. Hot bin screens are not required.

1. **Surge Bins:** Provide 1 or more bins large enough to produce 1 complete batch of mixture.

L. Hauling Equipment: Provide trucks with enclosed sides to prevent asphalt mixture loss. Cover each load of mixture with waterproof tarpaulins. Before use, clean all truck beds to ensure the mixture is not contaminated. When necessary, coat the inside truck beds with an approved release agent from the list maintained by the TxDOT's Construction Division.

M. Distributor: Furnish a distributor that will apply asphalt material uniformily at the specified rate or as directed.

1. **Transverse Variance Rate:** When a transverse variance rate is shown on the plans, ensure 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. The type and grade of asphalt material shown on the plans will be used to perform the test. If verification does not meet the requirements, correct deficiencies and furnish a new test report.

2. **Calibration:**

   a) **Transverse Distribution:** Furnish a distributor test report, no more than 1 year old that is signed and sealed by a Texas Licensed Engineer, 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, Part III. Include the following documentation on the test report:

      (1) The serial number of the distributor

      (2) a method that identifies the actual nozzle set used in the test, and

      (3) the fan width of the nozzle set at a 12 inch bar height.

   b) **Tank Volume:** Furnish a volumetric calibration and strap stick for the distributor tank in accordance with Tex-922-K, Part I. Calibrate the distributor within the previous 5 years of the date first used on the project. Calibration needs to be signed and sealed by a Texas Licensed Engineer. The ODR may verify calibration accuracy in accordance with Tex-922-K, Part II

N. **Placement and Compaction Equipment:** Provide equipment that does not damage underlying pavement. Comply with laws and regulations concerning overweight vehicles. When permitted, other equipment that will consistently produce satisfactory results may be used.

1. **Asphalt Paver:** Furnish a paver that will produce a finished surface that meets longitudinal and transverse profile, typical section, and placement requirements. Ensure the paver does not support the weight of any portion of hauling equipment other than the connection. Provide loading equipment that does not transmit vibrations or other motions to the paver that adversely affect the finished pavement quality. Equip the paver with an automatic, dual, longitudinal-grade control system and an automatic, transverse-grade control system.

2. **Tractor Unit:** Supply a tractor unit that can push or propel vehicles, dumping directly into the finishing machine to obtain the desired lines and grades to eliminate any hand finishing. Equip the unit with a hitch sufficient to maintain contact between the hauling equipment's rear wheels and the finishing machine's pusher rollers while mixture is unloaded.

3. **Screed:** Provide a heated compacting screed that will produce a finished surface that meets longitudinal and transverse profile, typical section, and placement requirements. Screed extensions must provide the same compacting action and heating as the main unit unless otherwise approved.

4. **Grade Reference:** Provide a grade reference with enough support that the maximum deflection does not exceed 1/16 in. between supports. Ensure that the longitudinal controls can operate from any longitudinal grade reference including a string line, ski, mobile string line, or matching shoes. Furnish paver skis or mobile string line at least 30 ft. long unless otherwise approved.

5. **Material Transfer Devices:** Provide the specified type of device when shown on the plans. Ensure the devices provide a continuous, uniform mixture flow to the asphalt paver. When used, provide windrow pick-up equipment constructed to pick up substantially all roadway mixture placed in the windrow.

6. **Remixing Equipment:** When required, provide equipment that includes a pug mill, variable pitch augers, or variable diameter augers operating under a storage unit with a minimum capacity of 8 tons.

7. **Motor Grader:** When allowed, provide a self-propelled grader with a blade length of at least 12 ft. and a wheelbase of at least 16 ft.

8. **Handheld Infrared Thermometer:** Provide a handheld infrared thermometer meeting the requirements of Tex-244-F.

9. **Rollers:** Provide rollers meeting the requirements of Subsection 4.22, "Rolling," for each type of roller required for compaction.

10. **Straightedges and Templates:** Furnish 10-ft. straightedges and other templates as required or approved.

O. Coring Equipment: When coring is required, provide equipment suitable to obtain a pavement specimen meeting the dimensions for testing.

III. 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.

LAST PAGE OF SECTION

Subsection 4.26
Weighing and Measuring Equipment

I. Scope: The contractor will provide weighing and measuring equipment for materials measured or proportioned by weight or volume.

II. Equipment: Provide certified scales, scale installations, and measuring equipment meeting the requirements of National Institute of Standard and Technology Handbook 44, except that the required accuracy must be 0.4% of the material being weighed or measured. Provide personnel, facilities, and equipment for checking the scales to the satisfaction of the ODR. Check all weighing and measuring equipment after each move and at least once each 6 months or when requested. Calibrate all scales using weights certified by the Texas Department of Agriculture or an equivalent agency approved by the ODR. Provide a written calibration report from a scale mechanic for all calibrations. Cease plant operations during the checking operation. Do not use inaccurate or inadequate scales. When adjusting equipment, bring performance errors as close as practicable to zero. Furnish sufficient certified weights to check the accuracy and sensitivity of the scales. Insulate scales against shock, vibrations, or movement of other operating equipment. On a daily basis, provide an automated ticket printout for each truckload of material where payment is determined by weight. Each loading ticket must show the ticket number, truck number, gross weight, tare weight, and net weight. If required on the plans for materials paid for by the ton, provide a summary spreadsheet that lists separately the ticket number, truck number, gross weight, tare weight, net weight, overload weight, and payment weight amounts as shown in Table 1. Submit all summary sheets, within 2 days of delivery of materials, provide the totals for net weight and overload amounts to be deducted. Include the overload deduction in the total amount reported for payment. Submissions are subject to verification by the ODR. Furnish leak-free weighing containers large enough to hold a complete batch of the material being measured.

Table 1
Example Spreadsheet

Ticket No.	Truck No.	Gross Wt.	Tare Wt.	Net Wt.	Overload Wt.	Payment Wt.
				Totals	Totals	Totals

A. Truck Scales: Furnish platform truck scales capable of weighing the entire truck or truck–trailer combination in a single draft.

B. Aggregate Batching Scales: Equip scales used for weighing aggregate with a quick adjustment at zero that provides for any change in tare. Provide a visual means that indicates the required weight for each aggregate.

C. Suspended Hopper: Provide a means for the addition or the removal of small amounts of material to adjust the quantity to the exact weight per batch. Ensure the scale equipment is level**.**

D. Belt Scales: Use belt scales for proportioning aggregate that are accurate to within 1.0% based on the average of 3 test runs, where no individual test run exceeds 2.0% when checked in accordance with Tex-920-K.

E. Asphalt Material Meter: Provide an asphalt material meter with an automatic digital display of the volume or weight of asphalt material. Verify the accuracy of the meter in accordance with Tex-921-K. When using the asphalt meter for payment purposes, ensure the accuracy of the meter is within 0.4%. When used to measure component materials only and not for payment, ensure the accuracy of the meter is within 1.0%.

F. Liquid Asphalt Additive Meters: Provide a means to check the accuracy of meter output for asphalt primer, fluxing material, and liquid additives. Furnish a meter that reads in increments of 0.1 gallons or less. Verify accuracy of the meter in accordance with Tex-923-K. Ensure the accuracy of the meter within 5.0%.

G. Particulate Solid and Slurry Additive Meters: Provide a means to check the accuracy of meter output for particulate solids (such as hydrated lime or mineral filler) and slurries (such as hydrated lime slurry). Ensure the accuracy of the meter within 5.0%.

III. 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.

LAST PAGE OF SECTION

Subsection 4.27
Rolling

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

II. 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 subsection. The ODR 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[1]

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

Roller Type	Materials to be Compacted	Load (tons)	Contact Pressure	Roller Speed (mph)
Grid	Embankment, base, breaking up existing asphalt mats or base	5–13	–	2–3

[1]Unless otherwise specified in the Contract.

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. Ensure 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 project 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 inches minimum diameter and a 5 foot minimum width, or 1 rear and 2 forward drums, each with a 60 inches 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:

   a) Project at least 7 inches from the drum surface;

   b) Have an area of 7 to 21 square inches;

   c) Are self-cleaning;

   d) Exert a static load of at least 550 psi; and

   e) Are spaced at 1 tamping foot per 0.65 to 0.70 square foot 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:

1. Separate frequency and amplitude controls;

2. Controls to manually start and stop vibration; and

3. A mechanism to continuously clean the face of the drum.

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

(1) Automatically reverse the direction of the rotating eccentric weight;

(2) Stop vibration before the motion of the roller stops; and

(3) Thoroughly moisten the drum with water or approved asphalt release agent.

Drum (Type A). Furnish a roller with a static weight less than 6 tons and a vibratory drum.

Drum (Type B). Furnish a roller with a minimum static weight of 6 tons and a vibratory drum.

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:

2. With at least 9 pneumatic tires;

3. With an effective rolling width of approximately 5 foot;

4. Capable of providing a total uniform load of 4.5 to 9 tons;

5. With tires capable of maintaining a minimum ground contact pressure of 45 psi;

6. Medium Pneumatic Tire. Furnish a unit;

7. With at least 7 pneumatic tires;

8. With an effective rolling width of approximately 7 foot;

9. Capable of providing a total uniform load of 12 to 25 tons; and

10. With tires capable of maintaining a minimum ground contact pressure of 80 psi or 90 psi as directed.

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

1. With at least 4 pneumatic-tired wheels mounted on axles carrying at most 2 wheels;

2. With wheels arranged to carry approximately equal loads on uneven surfaces;

3. With a width between 8 and 10 feet that can turn 180° in the crown width;

4. Capable of providing a total uniform load of at least 25 tons;

5. With tires capable of maintaining a maximum ground contact pressure of 150 psi; and

6. 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.

F. 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 1-1/2 inches wide, spaced on 5 inches centers in each direction, that undulate approximately 1 inch between the high and low points.

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

G. Alternate Equipment: Instead of the specified equipment, the Contractor may, as approved by the ODR or Engineer, 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**.**

III. Construction: Perform this work in accordance with the applicable Subsections 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.

IV. 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 subsections.

LAST PAGE OF SECTION

Subsection 4.28
Prime Coat

I. Scope: The Contractor will prepare and treat existing or newly constructed surface with a bituminous material. Apply blotter material as required**.**

II. Materials

A. Bituminous: Use material of the type and grade shown on the plans in accordance with Subsection 4.23, "Asphalts, Oils, and Emulsions."

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

III. Equipment: Provide applicable equipment in accordance with Subsection 4.25, "Equipment for Asphalt Concrete Paving."

IV. 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 ODR 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:** Apply bituminous mixture at a rate of 0.20 to 0.40 gallons per square yard as directed . The ODR or Engineer will select the application temperature within the limits recommended in Section 4.23, "Asphalts, Oils, and Emulsions." Distribute the material smoothly and evenly that covers the area uniformly at the rate selected by the ODR. Subsequent courses will not be applied until the prime has completely broken.

2. **Blotter:** Spread blotter material before allowing traffic to use a primed surface. 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.

D. Maintenance: If the primed surface has accumulated an unsatisfactory amount of dust, the base material shall be either re-primed or a tack coat applied.

Approval needs to be given by ODR before mix can be placed. Maintain the primed surface until placement of subsequent courses or acceptance of the work.

V. Measurement: This Subsection will be measured by the gallon of bituminous material placed and accepted.

VI. Payment: The work performed and materials furnished in accordance with this subsection will be paid for by unit price of "Prime" for 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.

LAST PAGE IN SECTION

Subsection 4.29
Cleaning and Sealing Joints and Cracks

I. Scope: The Contractor will clean and seal joints and cracks in asphalt concrete roadway surfaces.

II. Materials: Furnish materials unless otherwise shown on the plans. Supply sealant materials as shown on the plans in accordance with Subsection 4.23, "Asphalts, Oils, and Emulsions." Furnish fine aggregate in accordance with Subsection 4.17.II.A.2, "Fine Aggregate."

III. Equipment: Provide equipment, tools, and machinery for proper execution of the work. Hot applied sealants shall be applied unless otherwise shown in the plans.

A. Hot-Applied Sealants. Heat in a double jacketed heater using a heat transfer oil so no direct flame comes in contact with the shell of the vessel containing the sealing compound. Provide a heater capable of circulating and agitating the sealant during the heating process to achieve a uniform temperature rise and maintain the desired temperature. Provide gauges to monitor the temperature of the vessel contents and avoid overheating the material. Provide a heater equipped with a gear driven asphalt pump with adequate pressure to dispense the sealant.

B. Cold-Applied Sealants. Provide equipment with adequate pressure to dispense the sealant in a continuous flow.

IV. Construction: Apply sealant when the air or pavement temperature is within the manufacturer's recommendations or as approved. Clean and seal joints and cracks that are 1/16 inch or greater in width. Fill cracks with sand for cracks greater than ½ inch, or as shown on the plans. Rout joints and cracks to the configuration shown on the plans when required. Clean joints and cracks with air blast cleaning or other acceptable methods to a depth at least twice the joint or crack width. Joints and cracks must be free of moisture before sealing. Dispose of materials removed as directed or approved. Apply sealant with a pressure nozzle. Completely fill cracks and joints. Squeegee material to no more than 3 inches wide and 1/8 inch above the pavement surface. Prevent tracking with an application of fine aggregate as directed.

V. Measurement: This Subsection will be measured by the lane mile. Crack and joint sealing done as part of the City overlay will be considered subsidiary to the hot mix price.

VI. Payment: The work performed and materials furnished in accordance with this Subsection and measured as provided under "Measurement" will be paid for by unit price of "Joint and Crack Sealing" of the sealant material specified. This price is full compensation for routing, cleaning, and sealing joints and cracks, including blotter material, and equipment, labor, tools, and incidentals.

LAST PAGE IN SECTION

Subsection 4.30
Removing Treated and Untreated Base and Asphalt Pavement

I. Scope: Break, remove, and store or dispose of existing asphalt pavement, including surface treatments, and treated or untreated base materials. .

II. Construction: Break material retained by the City into pieces not larger than 6 inches. Remove existing asphalt pavement before disturbing the stabilized base. Avoid contamination of the asphalt materials and damage to adjacent areas. Repair material damaged by operations outside the designated locations. Stockpile materials designated salvageable at designated sites. Prepare stockpile site by removing vegetation and trash and by providing for proper drainage. Material not designated to be salvaged will become the property of the Contractor. When this material is disposed of, do so in accordance with federal, state, and local regulations.

III. Measurement: This Subsection will be measured by the 100-foot station along the baseline of each roadbed or by the square yard of existing treated or untreated base and asphalt pavement in its original position.

IV. Payment: The work performed in accordance with this Subsection and measured as provided under "Measurement" will be paid for at the unit price bid for "Removing Treated and Untreated Base and Asphalt Pavement" of the depth specified. This price is full compensation for breaking the material, loading, hauling, unloading, stockpiling or disposing; repair to areas outside designated locations for removal; and equipment, labor, tools, and incidentals.

LAST PAGE OF THIS SUBSECTION

Subsection 4.31
Proof Rolling

I. Scope: Proof-roll earthwork, base, or both to locate unstable areas.

II. Equipment

A. Specified Equipment: Furnish rollers that when loaded weigh at least 25 tons. The maximum acceptable load is 50 tons. Provide rollers that meet the requirements of Subsection 4.27.II.D, "Pneumatic Tire Rollers."

B. Alternative Equipment: The Contractor may use alternate compaction equipment that produces results, equivalent to the specified equipment in the same period of time as approved. Discontinue the use of the alternative equipment and furnish the specified equipment if the desired results are not achieved.

III. Construction: Perform proof rolling as directed. Adjust the load and tire inflation pressures within the range of the manufacturer's charts or tabulations, as directed. Make at least 2 coverages with the proof roller. Offset each trip of the roller by at most 1 tire width. Operate rollers at a speed between 2 and 6 miles per hour, as directed. Correct unstable or nonuniform areas, if found, in accordance with the applicable subsection.

IV. Measurement

A. Rolling will be measured by the hour operated on surfaces being tested.

B. Unstable material below elevation shall be paid for by the square yard.

V. Payment: The work performed and equipment furnished in accordance with this Subsection and measured as provided under "Measurement" will be paid for at the unit price bid for "Proof Rolling." This price is full compensation for furnishing and operating equipment and for labor, materials, tools, and incidentals.

LAST PAGE OF THIS SUBSECTION

Subsection 4.32
Sprinkling

I. Scope: Apply water for dust control, earthwork, or base construction.

II. Materials: Water usage shall conform to Subsection 3.04, "Requirements for Water Usage."

III. Equipment: Use sprinklers and spray bars equipped with positive and rapidly working cut-off valves.

IV. Construction: Apply water at a uniform rate and in the required quantity, or as directed.

V. Measurement: This Item will be measured by the 1,000 gallons applied.

VI. Payment: Unless sprinkling is specified as a pay item, the work performed and materials furnished in accordance with this Subsection will not be paid for directly but will be subsidiary to pertinent Items. When sprinkling is specified on the plans as a pay item, the work performed and water furnished will be paid for at the unit price bid for "Sprinkling (Base)," "Sprinkling (Earthwork)," or "Sprinkling (Dust Control)." This price is full compensation for furnishing and applying water; furnishing and operating sprinklers and measuring devices; and hauling, equipment, labor, fuel, materials, tools, and incidentals.

LAST PAGE OF THIS SUBSECTION

Subsection 4.33
Metal Beam Guard Fence

I. Scope: Furnish, install, remove, replace or adjust metal beam guard fence and guardrail end treatments consisting of metal beam rail elements, hardware, blocks, support posts and guardrail end treatments.

II. Materials

A. Metal Beam Rail Elements: Furnish new metal beam rail, transitions anchor sections, and terminals that meet the requirements of Table 1 and are from a manufacturer on TxDOT's Material Producer List (MPL). Warped or deformed rail elements will be rejected. Type I or II is required. Base metal for metal beam rail elements must not contain more than 0.04% phosphorous or more than 0.05% sulfur.

Table 1
Rail Element Requirements

Specification	AASHTO M 180
Class	A-Base metal nominal thickness 0.105 inches B- Base metal nominal thickness 0.135 Inches
Type	I-Zinc coated 1.80 Ounces per square foot minimum II-Zinc coated 3.60 ounces per square foot minimum
Shape	W-Beam Thrie Beam W-Beam to Thrie Ream Transition
Markings	Permanently mark each metal beam element with information required in AASHTO M 180. Markings must be on the back of the metal beam rail section away from traffic and visible after erection.

B. Posts: Furnish new round timber, rectangular timber, or rolled steel section posts in accordance with details shown on the plans and the following requirements:

1. Timber Posts: Meet the requirements of DMS-7200, "Timber Posts and Blocks for Metal Beam Guard Fence." Supply posts from a supplier on TxDOT's MPL.

2. Steel Posts: Furnish rolled sections conforming to the material requirements of ASTM A36. Drill or punch posts for standard rail attachment as shown on the plans. Galvanize according to ASTM A 123. Low fill culvert posts may be fabricated as galvanized "blanks" with the rail hole field drilled to height. Clean by steel brushing and then treat all exposed posts surfaces caused by field fabrication and other damage to coating using zinc-rich paint. Zinc rich paints must meet the requirements of DMS-8103 "Galvanizing Repair Paints." TxDOT's MPL maintains list of approved paints for galvanizing coatings.

C. Blocks: Furnish new rectangular timber or composite blocks in accordance with details shown on the plans and the following requirements:

a) Timber: Meet the requirements of DMS-7200 "Timber Posts and Blocks for Metal Beam Guard Fence." Material must be a supplier from TxDOT's MPL**.**

b) Composite: Meet the requirements of DMS-7210 "Composite Material Posts and Blocks for Metal Beam Guard Fence. Material must be a supplier from TxDOT's MPL.

D. Fittings: Furnish new bolts, nuts, washers according to the details shown in the plans. Fittings must be galvanized according to ASTM A 153.

E. Terminal Connectors: Furnish new terminal connectors, where required, meeting the material and galvanizing requirements specified for metal beam rail elements.

F. Concrete: Furnish concrete for terminal anchor posts meeting the requirements for 3000 pound concrete as required in Subsection 4.08 ,"Concrete."

G. Terminal Anchor Posts. Furnish new terminal anchor posts from steel conforming to the material requirements of ASTM A 36. Galvanize according to ASTM A 123. Clean by steel brushing and then treat all exposed post surface damage to coating using zinc-rich paint. Zinc rich paints must meet the requirements of DMS-8103 "Galvanizing Repair Paints." TxDOT's MPL maintains list of approved paints for galvanizing coatings.

H. Guardrail End Treatments: Furnish new materials from TxDOT's MPL.

III. Construction

A. Posts: Install posts by either drilling or driving.

1. Drilling: Drill holes and set posts plumb and firm to the line and grade shown on the plans. Backfill posts thoroughly compacting material to the density of adjacent undisturbed material.

2. Driving: Drive posts plumb with approved power hammers (steam, compressed air, vibratory, or diesel) or gravity hammers to the line and grade shown while preventing damage to the posts. For hard soils, pilot holes are allowed.

B. Rail Elements: Erect metal beam rail elements to produce a smooth, continuous rail paralleling the line and grade of the roadway surface or as shown on the plans. Bolt rail elements end-to-end and lap splices in the direction of traffic. Field-drill or punch poles when approved.

C. Guardrail End Treatments: Install guardrail end treatments in accordance with manufacturer's assembly and installation requirements and the details shown on the plans. Provide the ODR with manufacturer's installation and repair manuals specific to the guardrail end treatment.

D. Removal of Metal Beam Guard Fence and Guardrail End Treatments: Remove rail lengths in original lengths. Remove posts and fittings. Remove Guardrail end treatments. Do not mar salvageable materials during removal. Remove concrete around any posts and backfill. Neatly stack salvaged material to be retained by the City at location shown in the plans. Properly dispose of unsalvageable materials in accordance with federal, state and city regulations. Replace Contractor damaged material at the Contractor's expense.

IV. Measurement

A. Guard Fence: Fence will be measured by the linear foot along the face of the rail, from center-to-center of each splice location.

B. Terminal Anchor Section: Terminal post and one 25 foot rail section will be measured by each.

C. Guardrail End Treatment: Guardrail end treatments will be measured by each.

D. Removing Metal Beam Guard Fence: Removing fence will be measured by the linear foot in its original position from center-to-center of end posts.

E. Remove Terminal Anchor Section: Removing terminal anchor section will be measured by each and consist of one post and one 25 foot section of rail.

V. Payment: The work performed and materials furnished in accordance with this Subsection and measured as provided under Measurement will be paid at the unit bid. This price is full compensation for materials, removing, installing, stockpiling, hauling, disposing of materials, backfilling, equipment, labor, tools, and incidentals.