DIVISION 300

ROADWAY CONSTRUCTION

ITEM	SUBJECT
301	Subgrade, Subbase, and Base Preparation
302	Asphalt Materials and Pavement
303	Portland Cement Concrete Pavement
304	Concrete Paving Units
305	Miscellaneous Roadway Construction

ITEM 301. SUBGRADE, SUBBASE, AND BASE PREPARATION

301.1. GENERAL

Subgrade is that portion of the roadbed upon which the subbase, base or the pavement is to be placed. It includes 12-in. (30cm) beyond the back of the curb for streets, which are to be paved with concrete. Subbase is that layer of specified material of plan thickness between a base and a subgrade. Base is that layer of specified material of plan thickness placed immediately below the pavement course surfacing.

301.1.1. Subgrade Preparation.

301.1.1.1. Description. These specifications shall govern for the preparation of the subgrade except as otherwise provided or specified.

301.1.1.2. Equipment. All equipment necessary for the construction of this item shall be on the project and shall be approved by the CITY as to condition before the CONTRACTOR shall be permitted to begin construction operations on which the equipment is to be used. Any equipment that achieves the desired results in the time frame allowed is acceptable.

301.1.1.3. Construction Methods. After the excavation of embankment has been substantially completed, the subgrade shall be shaped so that after rolling as specified in Item 301.1.2. Rolling of Embankment, Subgrade or Flexible Base and subsequent finishing operations, it shall conform to the correct alignment, cross section and elevation. Rolling and sprinkling, as needed, shall be performed when and to the extent directed and the roadbed shall be completed to or above the plane of the typical section shown on the plans and the lines and grades established by the CITY.

After completion of the compaction and immediately before the application of subbase, base or pavement, the subgrade preparation equipment shall be operated using approved methods in a manner to finish the subgrade to the required section. The subgrade shall then be tested with the approved template, operated and maintained by the CONTRACTOR. All irregularities which develop in excess of ½-in. in a length of 16-ft. (13mm in 5m) measured longitudinally shall be corrected by loosening, adding or removing material; reshaping; and recompacting by sprinkling and rolling. The completed subgrade shall have a uniform density of not less than 95-percent of the maximum density determined by ASTM D698 Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft_3 (600 kN-m/m_3)). Moisture content shall be within minus-2- to plus-4-of-optimum.

The subgrade shall be maintained in a smooth, compacted condition, in conformity with the required section and established grade, until the subbase, base or pavement is placed, and shall be kept wetted down sufficiently in advance of placing any subbase, base or pavement to insure its being in a firm and moist condition for at least 2-in. (5cm) below surface of the prepared subgrade. Only such subgrade as is necessary for the satisfactory execution of the work shall be completed ahead of the placement of base or pavement. Hauling or operating of unnecessary equipment on the completed subgrade shall be kept to a minimum. If equipment is operated on recent work, the CITY may inspect and require subgrade replacement for such defects as fractures, rutting, or any other failure. Complete drainage of the subgrade shall be provided at all times.

Finishing of the subgrade by other methods shall be permitted on pavement widening projects, on sections where the pavement width is not uniform, at intersections and elsewhere where the operation of certain equipment would not be practical. Subgrade finished by hand or other methods shall conform to the requirements above specified.

301.1.2. Rolling of Embankment, Subgrade or Flexible Base

301.1.2.1. Description. Rolling shall consist of the compaction of embankment, subgrade or flexible base by the operation of approved power rollers, as herein specified and as directed by the CITY.

301.1.2.2. Roller Requirements. All equipment necessary for the construction of this item shall be on the project and shall be approved by the CITY as to condition before the CONTRACTOR shall be permitted to begin construction operations on which the equipment is to be used. Any equipment that achieves the desired results in the time frame allowed is acceptable. If equipment fails to produce the desired result within the required time frame, its use shall be discontinued and the CONTRACTOR will be required to furnish equipment, as determined by the Engineer, at no additional cost to the CITY.

Sufficient rollers shall be provided to compact the material in a manner satisfactory to the CITY. When operations are so isolated from one another that one roller unit cannot perform the required compaction satisfactorily, the CONTRACTOR shall provide additional roller units.

301.1.2.3. Rolling Methods. The embankment, subgrade or base course shall be sprinkled as directed by the CITY. Rolling patterns and speeds shall be established per project and indicated on the plans.

301.2. LIME TREATMENT

This item shall consist of treating subgrade, subbase, and base courses by the pulverization, addition of lime, mixing and compacting the mixed material to the required density. This item applies to natural ground, embankment, or pulverized recycled asphalt pavement base or subbase courses placed under this contract, which shall be constructed as specified herein and in conformity with the typical section, lines and grades as shown on the plans.

301.2.1. Materials.

301.2.1.1. Hydrated Lime (Slurry).

301.2.1.1.1. General. Hydrated lime slurry shall be a pumpable suspension of solids in water. The solids portion of the mixture, when considered on the basis of “solids content,” shall consist principally of hydrated lime of a quality and fineness sufficient to meet the following requirements as to chemical composition and residue.

301.2.1.1.2. Chemical Composition. The “solids content” of the lime slurry shall have a hydrate alkalinity $Ca(OH)_2$ of not less than 90-percent by weight.

301.2.1.1.3. Residue. The percent by weight of residue retained in the “solid content” of lime slurry shall conform to the requirements in Table 301.2.1.1.3.(a) Hydrated Lime.

Table 301.2.1.1.3.(a) Hydrated Lime

Sieve Size	Residue Retained, Percent by Weight
No. 6 (3360 micron)	None
No. 10 (2000 micron)	Max. 1.0%
No. 30 (590 micron)	Max. 2.5%

301.2.1.1.4. Slurry Grades. Type B, commercial lime slurry, shall conform to one of the following three grades:

(1) Grade 1: The “dry solids contents” shall be at least 31-percent by weight of the slurry.
(2) Grade 2: The “dry solids contents” shall be at least 35-percent by weight of the slurry.
(3) Grade 3: The “dry solids contents” shall be at least 46-percent by weight of the slurry.

When Type B, commercial lime slurry, is specified, the CONTRACTOR shall select, prior to construction, the grade to be used and shall notify the CITY in writing before changing from one grade to another.

301.2.1.2. Quicklime.

301.2.1.2.1. General. Quicklime is a dry material consisting essentially of calcium oxide. It shall be furnished either in “pebble” gradation suitable for dry placing and slurry placing, or as a dry powder suitable only for slurry placing. Powdered quicklime is restricted to slurry placing, as the possibility of appreciable amounts of finely divided powdered quicklime makes it unsuitable for dry placing.

301.2.1.2.2. Chemical Composition. Quicklime shall conform to the chemical requirements of ASTM C977 Quicklime and Hydrated Lime for Soil Stabilization.

CAUTION: HANDLING AND USE OF QUICKLIME CAN BE DANGEROUS. QUICKLIME SHOULD BE PRESCRIBED BY A REGISTERED PROFESSIONAL ENGINEER FAMILIAR WITH ITS USE.

301.2.1.3. Tests. If the minimum design strength or percent lime to be used for the treated subgrade, existing base, new subbase or new base is specified, it shall be determined by preliminary laboratory tests at the CITY'S expense. Optimum lime addition percentage shall be determined by Tex-112-E Admixing Lime to Reduce Plasticity Index of Soils (Atterberg Limits Soil-Lime Series) and/or by ASTM D6276 Test Method for Using pH to Estimate the Soil-Lime Proportion Requirement for Soil Stabilization (pH Soil-Lime Series.)

301.2.1.4. Lime Delivery and Storage. If hydrated lime is furnished in bags, each bag shall bear the manufacturer's certified weight. Bags varying more than 5-percent by weight may be rejected, and the average weight of the bags in any shipment, as shown by weighing 50 bags taken at random, shall not be less than the manufacturer's certified weight. If lime is furnished in trucks, each truck shall bear the weight of lime measured on certified scales, or the CONTRACTOR shall place a set of standard platform truck scales or hopper scales at a location approved by the CITY.

Hydrated lime and quicklime shall be stored and handled in closed, weatherproof containers until immediately before distribution on the road. If storage bins are used, they shall be completely enclosed. Hydrated lime bags shall be stored in weatherproof buildings with adequate protection from ground dampness. Quicklime, when permitted, shall be shipped only in bulk; bagged material shall not be acceptable.

301.2.1.5. Water. Water shall conform to the requirements of Item 303.2.7. Water.

301.2.1.6. Soil. The soil shall consist of the in-situ soil or approved soil, free from vegetation, roots, or other objectionable matter. It may be either the material encountered in the existing section, material secured from approved sources shown on the plans or as designated by the CITY, or a combination of existing and additional soil from approved sources, as shown on the plans, or as directed by the CITY.

301.2.1.7. Recycled/Reclaimed Asphalt Pavement. Recycled/Reclaimed asphalt pavement is defined as a salvaged, milled, pulverized, broken or crushed asphaltic pavement uncontaminated by dirt or other objectionable materials.

301.2.1.8. Rejection. Any materials that do not conform to the requirements of this specification shall be rejected.

301.2.2. Equipment. Machinery, tools and equipment necessary for proper performance of the work shall be on the project and approved by the CITY prior to the beginning of construction operations.

When permitted, quicklime shall be slurried in agitated slurry tanks. The distributor truck used for slurry placing need not necessarily be equipped with an agitator. However, the slurry at the time of distribution must meet the consistency requirements specified.

All machinery, tools and equipment used shall be maintained in a satisfactory and workmanlike manner.

301.2.3. Lime Treatment Construction Methods.

301.2.3.1. General. It is a primary requirement of this specification to secure a completed course of treated material containing a uniform lime mixture, free from loose or segregated areas, or uniform density and moisture content, well bound for its full depth, and with a smooth surface and suitable for placing subsequent courses. It shall be the responsibility of the CONTRACTOR to regulate the sequence of work, to use the proper amount of lime, maintain the work and rework the courses as necessary to meet the above requirements.

Prior to beginning any lime treatment, the roadbed shall be constructed and shaped to conform to the typical sections, lines and grades as shown on the plans or as established by the CITY.

In cases where groundwater is present, application of lime for stabilization shall be evaluated by the CITY.

301.2.3.2. General Construction.

301.2.3.2.1. Treatment for Materials in Place. Materials to be treated shall be excavated to the secondary grade (proposed bottom of lime treatment) and removed or windrowed to expose the secondary grade. Any wet or unstable material below the secondary grade shall be corrected by scarifying, adding lime and compacting until it is of uniform stability. The excavated material shall then be spread to the desired cross section.

If the CONTRACTOR elects to use a cutting or pulverizing machine that shall remove the subgrade material accurately to the secondary grade and to pulverize the material at the same time, CONTRACTOR shall not be required to expose the secondary grade or windrow the material. However, the CONTRACTOR shall be required to roll the subgrade before using the pulverizing machine and correct any soft areas that this rolling may reveal. This method shall be permitted only where a machine is provided which shall insure that the material is cut uniformly to the proper depth and which has cutters that shall place the secondary grade to a smooth surface over the entire width of the cut. The machine shall be of such design that a visible indication is given at all times that the machine is cutting to the proper depth.

301.2.3.2.2. Treatment for New Materials. The base and subbase materials, as provided in the governing specifications, shall be delivered, placed and spread in the required amount per station. The material shall be manipulated as specified and thoroughly mixed prior to the addition of the lime.

301.2.3.3. Lime Application. Lime shall be spread only on that area where the first mixing operation can be completed in the same working day, except that quicklime shall be mixed at the time of application. The application and mixing of lime with the materials shall be accomplished by the methods hereinafter described unless otherwise approved by the CITY.

301.2.3.3.1. Dry Placing Quicklime. Quicklime may be placed dry if it is in pebble form. A spreader or motor grader shall be used to spread pebble Quicklime.

301.2.3.3.2. Slurry Placing.

Hydrated Lime or Commercial Lime Slurry. Lime shall be mixed with water and applied as a thin water suspension or slurry. Type B, commercial lime slurry, shall be applied with a lime percentage not less than that applicable for the grade used. The distribution of lime at the rate shown on the plans shall be attained by successive passes over a measured surface of roadway until the proper moisture and lime content have been achieved.

Quicklime. When Quicklime is applied as a slurry, the amount of dry quicklime shall be 80-percent of the amount shown on the plans. The residue from the Quicklime slurrying procedure shall be spread uniformly over the length of the roadway currently being processed unless otherwise approved by the CITY. This residue is primarily inert material with little stabilizing value, but may contain a small amount of Quicklime particles that slake slowly. A concentration of these particles could cause the compacted stabilized material to swell during slaking.

301.2.3.4. Mixing. Mixing procedure shall be the same for “dry placing” or “slurry placing” as hereinafter described.

301.2.3.4.1. Treatment for Materials-In-Place. Material and lime shall be thoroughly mixed by approved road mixers or other approved equipment and the mixing continued until a homogeneous, friable mixture of material and lime is obtained, free from all clods or lumps. Materials containing plastic clay or other materials which shall not readily mix with lime shall be mixed as thoroughly as possible at the time of the lime application, brought to the proper moisture content, sealed with a pneumatic roller, and left to cure 1- to 4-days as directed by the CITY. During the curing period, the material shall be kept moist. After the required curing time, the material shall be uniformly mixed by approved methods. If the soil binder lime mixture contains clods, they shall be reduced in size by raking, blading, discing, harrowing, scarifying or the use of other approved pulverization methods so that when all nonslaking aggregates obtained on the No. 4 sieve are removed, the remainder of the material shall meet the requirements of Table 301.2.3.4.1.(a) Lime Treated Materials-In-Place when tested dry by laboratory sieves.

Table 301.2.3.4.1.(a) Lime Treated Materials-In-Place

Sieve Size	Minimum Passing
1¾-in. (45mm)	100%
No. 4 (4.75mm)	60%

1. Recycled asphalt pavement shall be pulverized so that 100-percent shall pass a 2-in. (50mm) sieve.

During the interval of time between application and mixing, hydrated lime that has been exposed to the open air for a period of 6-hours or more, or to excessive loss due to washing or blowing, shall not be accepted for payment.

In addition to the above, when pebble quicklime is used, the material and lime shall be mixed as thoroughly as possible at the time of application. Sufficient moisture shall be added during the mixing to hydrate the quicklime. After mixing, and prior to compaction, the mixture of material, quicklime and water shall be moist cured for 2- to 7-days, as approved by the CITY. After curing, mixing shall continue until the pulverization requirements are met.

301.2.3.4.2. Treatment of New Material. The base or subbase material, lime and required water shall be thoroughly mixed and blended by approved road mixers or other approved equipment and the mixing continued until a homogeneous, friable mixture is obtained. When lime is placed as a slurry and mixed by the use of blades, the material shall be bladed as the lime water mixture is applied; after the total amount has been placed, the mixture shall be thoroughly blended to the satisfaction of the CITY.

During the interval of time between application and mixing, hydrated lime that has been exposed to the open air for a period of 6-hours or more, or to excessive loss due to washing or blowing, shall not be accepted for payment.

301.2.3.5. Compaction. Compaction of the mixture shall begin immediately after final mixing and in no case later than 3-days after final mixing. The material shall be aerated or sprinkled as necessary to provide optimum moisture. Compaction shall begin at the bottom and shall continue until the entire depth of the mixture is uniformly compacted as shown on the plans or specified by the CITY. The compacted mixture shall have a uniform density of not less than 95-percent of the maximum density as determined by ASTM D698 Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft_3 (600 kN-m/m_3)). Moisture content shall be within minus-2- to plus-4-of-optimum. After each section is completed, such tests as are necessary shall be made by the CITY. If any portion fails to meet the density specified, it shall be reworked as necessary to obtain the specified density. After the mixture has been compacted, the surface shall be shaped to the required line, grades and cross sections and then thoroughly rolled sufficiently lightly to prevent hairline cracking.

301.2.3.6. Maintenance. The CONTRACTOR shall be required to maintain the completed soil lime base within the limits of its contract in good condition, satisfactory to the CITY as to grade, crown and cross section until such time as the surface course is constructed. The surface of the compacted layer shall be kept moist until covered by other base or paving material or application of a curing seal of emulsified asphalt conforming to requirements of Item 302.3.5. Emulsions for Priming, Curing and Erosion Control (PCE). If a curing seal is used, it should be applied as soon as possible after completion of final rolling, at a rate of between 0.10- and 0.20-gallons-per-square-yard (0.5- to 1.0-liters-per-m_2), the exact rate to be determined by the CITY. No equipment or traffic shall be permitted on lime treated material for 72-hours after curing seal is applied, unless otherwise permitted by the CITY. In cases where subgrade treatment or subbase sets up sufficiently to prevent objectionable damage from traffic, such layers may be opened to traffic 2-days after compaction. The CONTRACTOR shall immediately repair all irregularities or other defects that may occur at the CONTRACTOR'S expense. Repairs are to be made as directed by the CITY and in a manner to insure restoration of a uniform surface and durability of the portion repaired.

301.3. PORTLAND CEMENT TREATMENT

This item shall consist of the treatment of the subgrade, subbase or base course which is to be composed of a compacted mixture of soil, and/or pulverized recycled asphalt pavement, Portland cement and water and shall be constructed as herein specified and in conformity to the cross sections, lines and grades as established by the CITY . In the event new materials are placed, rather than using in-situ soils, the subbase or base shall be constructed as herein specified and in conformity with the items governing the base or subbase courses.

301.3.1. Materials.

301.3.1.1. Portland Cement. Cement shall be ASTM C150 Type I, II or IP and conform to the requirements of Item 303.2.2. Portland Cement.

301.3.1.2. Water. Water shall conform to the requirements of Item 303.2.7. Water.

301.3.1.3. Soil. The soil shall consist of the in-situ soil or approved soil, free from vegetation, roots, or other objectionable matter. It may be either the material encountered in the existing section, material secured from approved sources shown on the plans or as designated by the CITY, or a combination of existing and additional soil from approved sources, as shown on the plans, or as directed by the CITY.

301.3.1.4. Recycled/Reclaimed Asphalt Pavement. Recycled/Reclaimed asphalt pavement is defined as a salvaged, milled, pulverized, broken or crushed asphaltic pavement uncontaminated by dirt or other objectionable materials.

301.3.2. Equipment. All equipment necessary to properly prosecute, perform and complete the work within the contract time shall be on the project and shall be approved by the CITY as to type and condition before the CONTRACTOR shall be permitted to begin construction operations on which the equipment is to be used.

The cement-modified soil layer may be constructed with any machine or combination of machines and auxiliary equipment that shall produce the results meeting the requirements for soil pulverization, cement application, water application, mixing, incorporation of materials, compaction, finishing and curing as specified herein. The CONTRACTOR shall at all times provide sufficient equipment to enable continuous performance of the work and its completion in the required number of working days.

301.3.3. Portland Cement Treatment Construction Methods.

301.3.3.1. General. The primary requirement of this specification is to secure a complete course of treated material containing a uniform Portland cement mixture, free from loose or segregated areas, of uniform density and moisture content, well bound and compacted for its full depth with a smooth surface suitable for placing additional subbase, base or surface courses. It shall be the responsibility of the CONTRACTOR to regulate the sequence of work, to process a sufficient quantity of material so as to provide full depth as shown on plans, to use the proper amount of Portland cement, maintain the work and to rework the courses as necessary to meet the foregoing requirements.

Cement stabilized base shall not be mixed or placed when the air temperature is below 40°F (5°C) andfalling, but may be mixed or placed with the air temperature is above 35°F (2°C) and rising, the temperature being taken in the shade and away from artificial heat, and with the further provisions that cement stabilized base shall be mixed or placed only when weather conditions, in the opinion of the CITY, are suitable.

301.3.3.2. Treatment for Materials-In-Place. Before other construction operations are begun, the roadbed shall be graded and shaped as required to construct the Portland cement treatment for material in place in conformance with the lines, grades, thickness and typical cross sections shown on the plans. Unsuitable soil or material shall be removed and replaced with acceptable soil. The subgrade shall be firm and able to support without displacement the construction equipment and achieve the compaction herein specified. Soft or yielding subgrade shall be corrected and made stable before construction proceeds.

The soil and/or recycled asphalt pavement shall be so pulverized that at the completion of moist-mixing, it meets the gradation in Table 301.3.3.2.(a) Cement Treated Materials-In-Place.

Table 301.3.3.2.(a) Cement Treated Materials-In-Place

Sieve Size	Minimum Passing by Dry Weight[1,2]
1-in. (25mm)	100%
No. 4 (4.75mm)	80%

1. Exclusive of gravel or stone retained on these sieves.
2. Recycled asphalt pavement shall be pulverized so that 100-percent shall pass a 2-in. (50mm) sieve.

301.3.3.2.1. Application of Cement to Materials-In-Place. Portland cement shall be spread by an approved dry or slurry method uniformly on the soil at the rate specified on the plans or as determined by preliminary laboratory tests. If a bulk cement spreader is used, it shall be positioned by string lines or other approved method during spreading to insure a uniform distribution of cement. Cement shall be applied only to such an area that all the operations can be continuous and completed in daylight within 6-hours of such application.

The percentage of moisture in the soil at the time of cement application shall not exceed the quantity that shall permit uniform and intimate mixture of soil and cement during dry-mixing operations, and it shall not exceed the specified optimum moisture content for the soil and cement mixture. In the event of high soil-moisture contents, cement may be applied at one-half the specified rate when approved by the Engineer. The remainder of the application rate of cement shall be applied the following day(s), not to exceed 48-hours. The usual construction sequence shall then be resumed.

No equipment, except that used in the spreading and mixing, shall be allowed to pass over the freshly spread cement until it is mixed with the soil.

301.3.3.2.2. Mixing and Processing of Stabilized Materials-In-Place. Any method used to achieve the specified results is acceptable. Mixing shall continue until a homogeneous, friable mixture of the material and cement is obtained, free from all clods or lumps. The mixture shall be kept within moisture tolerances throughout the operation.

301.3.3.2.3. Compaction and Finishing of Stabilized Materials-In-Place. Compaction shall begin after mixing and after gradation and moisture requirements have been met. The material shall be compacted to

at least 95-percent of the maximum density as determined by ASTM D698 Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft_3 (600 kN-m/m_3)). At the start of compaction, the percentage of moisture in the mixture and in unpulverized soil lumps, based on oven-dry weights, shall be within 2-percentagepoints of the specified optimum moisture content and shall be less than the quantity which shall cause the soilcement mixture to become unstable during compaction and finishing. When the uncompacted soil-cement mixture is wetted by rain so that the average moisture content exceeds the tolerance given at the time of final compaction, the entire section shall be reconstructed in accordance with this specification at the sole expense of the CONTRACTOR. The specified optimum moisture content and density shall be determined in the field on the representative samples of soil-cement mixture obtained from the area being processed. Final moisture content shall be within minus-2- to plus-4-of-optimum.

Prior to the beginning of compaction, the mixture shall be in a loose condition for its full depth. Compaction shall begin at the bottom and shall continue until the entire depth of the mixture is uniformly compacted. The loose mixture shall then be uniformly compacted to the specified density within 2-hours. After the soil and cement mixture, except the top mulch, is compacted, water shall be uniformly applied as needed and thoroughly mixed in. The surface shall then be reshaped to the required lines, grades and cross section and then lightly scarified to loosen any imprint left by the compacting or shaping equipment.

The resulting surface shall be thoroughly rolled with a pneumatic tire roller and “clipped,” “skinned,” and “tight-bladed” by a power grader to a depth of approximately ¼-in. (6mm), moving all loosened soil and cement from the section. The surface shall then be thoroughly compacted with the pneumatic roller, adding small increments of moisture as needed during rolling. When directed by the CITY, surface finishing methods may be varied from this procedure, provided a dense, uniform surface, free of surface material, is maintained at its specified optimum during all finishing operations. Surface compaction and finishing shall proceed in such a manner as to produce, in not more than 2-hours, a smooth, closely knit surface, free of cracks, ridges or loose material, conforming to the drawn grade and line shown on the plans.

CITY shall conduct In-place density tests shall as outlined in ASTM D2922 Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth). In-place density tests shall be performed at the rate of one-per-300-linear-ft. (1-per-91m) of paving for two (2) lanes. The suitability of the modification shall be confirmed by Atterberg Limit testing at the rate of one-test-per-2,500-cubic-yards (one-per-1,910-m_3) of processed 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 CITY. If the material fails to meet the density requirements, it shall be reworked 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 material, due to any reason or cause, lose the stability, density and finish before the next course is placed or the work is accepted, it shall be recompacted and refinished at the sole expense of the CONTRACTOR.

301.3.3.3. Plant-Mixed Cement Treated Base.

301.3.3.3.1. Subgrade Preparation. Before other construction operations are begun, the area to be paved shall be graded and shaped as required to receive the cement treated base in conformance with the grades, lines, thicknesses and typical cross-section shown on the plans. Unsuitable subgrade soil or material shall be removed and replaced with acceptable soil. The subgrade shall be firm and able to support without displacement of the construction equipment and compaction. Soft or yielding subgrade shall be corrected and made stable before construction proceeds.

301.3.3.3.2. Mixing and Processing for Plant-Mixed Cement Treated Base. The aggregate, cement and water shall be mixed in a pug mill as approved by the Engineer. The plant shall be equipped with feeding and metering devices that add the aggregate, cement and water into the mixer in the specified quantities to produce a mixture that meets or exceeds the mix design criteria. Aggregate and cement shall be mixed sufficiently to prevent cement balls from forming when the mix water is added. Mixing time shall be sufficient to assure an intimate, uniform mixture of aggregate, cement and water. The percentage of moisture in the aggregate, at the time of cement application shall be the amount that assures a uniform and intimate mixture of aggregate and cement during mixing operations. It shall not exceed the specified moisture content required for adequate compaction.

Free access to the plant shall be provided to the CITY for construction quality control. The mixture shall be hauled to the paving area in trucks having beds cleaned of deleterious material.

301.3.3.3.3. Placement of Plant-Mixed Cement Treated Base. The mixture shall be placed on a moistened subgrade in a uniform layer by any approved method of spreading that will deposit the required

quantity per lineal foot, without segregation, to produce a uniformly compacted base conforming to the grade and cross-section. Not more than 30-minutes shall elapse between placement of cement treated base in adjacent lanes at any location except at longitudinal and transverse construction joints. Compaction shall start as soon as possible after spreading. Elapsed time between the addition of water to the cement treated base mixture and the start of compaction shall not exceed 60-minutes under normal conditions. The Engineer may alter this time if environmental conditions, such as temperature, humidity or wind conditions would justify such a change. Laboratory tests may be required to verify changes in compaction time limits.

301.3.3.3.4. Compaction and Finishing of Plant-Mixed Cement Treated Base. At the start of compaction, the percentage of moisture in the mixture shall not be more than one-percentage-point-below or two-percentage-points-above the specified optimum moisture content, and shall be less than that quantity which will cause the cement treated base mixture to become unstable during compaction and finishing. The specified optimum moisture content and density shall be determined in the field by a Moisture-Density Test AASHTO T134 or ASTM D558 Test Methods for Moisture-Density Relations of Soil-Cement Mixtures, on representative samples of cement treated base mixture obtained from the area prior to compaction. Prior to compaction, the mixture shall be in a loose condition for its full depth. The loose mixture shall then be compacted uniformly to the specified density. During compaction operations, initial shaping may be required to obtain uniform compaction and required grade and cross-section.

When initial compaction is completed, the surface of the cement treated base shall be shaped to the required lines, grades and cross-section. The moisture content of the surface material shall be maintained at not less than its specified optimum moisture content during finishing operations. If any reshaping of the surface is necessary, it shall be lightly scarified to remove any compaction planes, scales or smooth surfaces left by equipment. Final compaction shall then be continued until uniform and adequate density is obtained. Cement treated base shall be uniformly compacted to a minimum of 95-percent of maximum density. Compaction and finishing shall be done in such a manner as to produce, in not longer than two-hours, a smooth, dense surface free of compaction planes, cracks, ridges, or loose material.

301.3.3.4. Finishing and Preparation for Surfacing. After the final layer or course of the cementmodifiedsoil has been compacted, it shall be brought to the required lines and grades in accordance with the typical sections. The completed section shall then be finished by rolling as directed with a pneumatic tire or other suitable roller sufficiently light to prevent hair cracking. Preparation for final surfacing may begin immediately.

301.3.3.5. Protection and Cover. After the roadway has been finished as specified herein, it shall be immediately protected against rapid drying by applying a curing seal of emulsified asphalt at the rate of 0.2-gallon-per-square-yard (0.7-L-per-m_2). The curing seal shall consist of emulsified asphalt conforming to requirements of Item 302.3.5. Emulsions for Priming, Curing and Erosion Control (PCE). Immediately prior to application of the curing seal, the section shall be wetted by the use of pressure water distributors so that all voids in the soilcement surface are filled with water, but without free water standing on the surface. The curing seal shall be applied while this moisture condition exists so that undue asphalt penetration of the soil-cement surface shall be prevented; and at the same time aided in complete coverage by the curing seal.

Should it be necessary for construction equipment or other traffic vehicles to pass over the section before the curing seal has dried sufficiently to prevent pickup, if shall be the responsibility of the CONTRACTOR to dust or sand the surface before such use. The CONTRACTOR shall also maintain the curing cover for 7-days so that all of the soil-cement base course shall be covered effectively with curing seal during this period. The curing seal shall remain in place for the additional asphalt-wearing surface.

301.3.3.6. Opening to Traffic. The CONTRACTOR shall not be permitted to drive heavy equipment over completed portions. Pneumatic-tired equipment required for hauling cement and water may be permitted to drive over after the surface has hardened sufficiently to prevent the equipment from marring the surface, provided that protection and cover are not impaired. The soil-cement course may be opened to local traffic as soon as the curing seal has been applied and dusted or sanded as necessary to prevent it from being picked up by traffic. Completed portions may be opened to all traffic after 7-days.

301.3.3.7. Maintenance. The CONTRACTOR shall be required within the limits of its contract to maintain the soil-cement treatment in good condition from the time it first starts work until all work shall have been completed. Maintenance shall include immediate repairs of any defect that may occur after the cement is applied. Such maintenance work shall be done by the CONTRACTOR at the CONTRACTOR'S expense and repeated as often as necessary to keep the area continuously intact. Repairs are to be made in such a manner as to insure restoration of a uniform surface for the full depth of treatment. Any low area of treated subgrade shall be remedied by scarifying the surface to a depth of at least 2-in. (5cm), filling the area with treated material and compacting. Any low area of subbase or base shall be remedied by replacing the material for the full depth of subbase or base treatment rather than adding a thin layer of stabilized material to the completed work.

301.4. ASPHALT EMULSION TREATMENT

This item shall consist of treating subgrade, subbase, and base courses by the pulverization, addition of asphalt base stabilization agent, mixing and compacting the mixed material to the required density. This item applies to natural ground, embankment, base or subbase courses placed under this contract, which shall be constructed as specified herein and in conformity with the typical section, lines and grades as shown on the plans.

Asphalt stabilization of recycled material such as crushed concrete or other non-hazardous recycled materials, processed recycled asphalt pavements, bottom ash, foundry slag, glass, recycled crumb rubber to create subgrade, subbase or base courses shall conform to TxDOT Special Specification 3157 Cold Processed - Recycled Paving Material (RPM) for Use as Aggregate Base Course. Asphalt emulsion for such recycling shall conform to Item 302.3.6. Specialty Emulsions or Item 302.3.7. Emulsion for In-Place Asphalt Recycling, as specified by the CITY.

301.4.1. Materials.

301.4.1.1. Asphalt Soil (Base) Stabilization Agent. The product shall be composed of petroleum of resin oil base with selective hardening and drying agents to form a stable subgrade, subbase, or base. Independent laboratory tests shall certify compliance with requirements of Table 301.4.1.1.(a) Asphalt Soil Stabilization Agent Requirements, as specified on the plans.

If the minimum design strength or percent asphalt base stabilization agent to be used for the treated subgrade, existing base, new subbase or new base is specified, it shall be determined by preliminary laboratory tests at the CITY'S expense.

301.4.1.2. Base and Subbase Materials. Base and subbase materials shall meet the requirements shown on the plans or in the pertinent specifications.

301.4.1.3. Delivery and Storage. If asphalt base stabilization agent is furnished in trucks, each truck shall bear the weight of asphalt base stabilization agent measured on certified scales, or the CONTRACTOR shall place a set of standard platform truck scales or hopper scales at a location approved by the CITY.

Asphalt base stabilization agent shall be stored and handled in tank, tanker or distributor truck until immediately before distribution on the road. Asphalt base stabilization agent shall be stored in freeze-proof containers.

301.4.2. Equipment. Machinery, tools and equipment necessary for proper performance of the work shall be on the project and approved by the CITY prior to the beginning of construction operations. All machinery, tools and equipment used shall be maintained in a satisfactory and workmanlike manner.

301.4.3. Asphalt Emulsion Treatment Construction Methods.

301.4.3.1. General. It is a primary requirement of this specification to secure a completed course of treated material containing a uniform asphalt base stabilization agent mixture, free from loose or segregated areas, of uniform density and moisture content, well bound for its full depth, and with a smooth surface and suitable for placing subsequent courses. It shall be the responsibility of the CONTRACTOR to regulate the sequence of work, to use the proper amount of asphalt base stabilization agent, maintain the work and rework the courses as necessary to meet the above requirements.

Prior to beginning any asphalt base stabilization agent treatments, the roadbed shall be constructed and shaped to conform to the typical sections, lines and grades as shown on the plans or as established by the CITY.

Table 301.4.1.1.(a) Asphalt Soil Stabilization Agent Requirements

Property	Test Method, Test	Value	
		Minimum	Maximum
Appearance	Visual Inspection	Brown Liquid	
Viscosity S.F. at 77°F Sec	ASTM D244 Emulsified Asphalts	5	175
Residue, % min	ASTM D244, modified[1]	55	65
Penetration 77°F, Sec		5	40
Miscibility Test	ASTM D244, modified[2]	No coagulation	
Moisture, wt %		-	45
Volatile %		25	-
% Non-Volatile Soluble in Trichloroethylene	AASHTO T 45-56	-	8
Accelerated Weathering (2-year exposure)	Federal Spec TT C-555 B, 40 ml	No material deterioration after exposure	
Resistance To wind and Driven Rain (@ 98 mph)	Federal Spec TT C-555 B, As 4ml sealer after cure	Passes/no wt. gain	
Ash, % wt.		-	8
Polymer, % wt.		-	4
Particle Charge	ASTM D244	Positive	
Flash Point	TCC	275°F	
Shaker Test 2- to 4-hrs.	Mix Burrell Wrist Action Shaker Model 75 set on Level 7, diluted 1 part water to 4 parts soil stabilizer, Sieve #40	-	1%

1. ASTM D244 Modified Evaporation Test for percent of residue is made by heating 50-gram sample to 300°F until foaming ceases, then cool immediately and calculate results.
2. Test procedure identical with ASTM D244, except that 0.02 Normal Calcium Chloride solution shall be used in place of distilled water.

301.4.3.2. General Construction.

301.4.3.2.1. Treatment for Materials-In-Place. Materials to be treated shall be excavated to the secondary grade (proposed bottom of asphalt base stabilization agent) and removed or windrowed to expose the secondary grade. Any wet or unstable material below the secondary grade shall be corrected by scarifying,adding asphalt base stabilization agent and compacting until it is of uniform stability. The excavated material shall then be spread to the desired cross section.

If the CONTRACTOR elects to use a cutting or pulverizing machine that shall remove the subgrade material accurately to the secondary grade and to pulverize the material at the same time, CONTRACTOR shall notbe required to expose the secondary grade or windrow the material. However, the CONTRACTOR shall be required to roll the subgrade before using the pulverizing machine and correct any soft areas that this rolling may reveal. This method shall be permitted only where a machine is provided which shall insure that the material is cut uniformly to the proper depth and which has cutters that shall place the secondary grade to a smooth surface over the entire width of the cut. The machine shall be of such design that a visible indication is given at all times that the machine is cutting to the proper depth.

301.4.3.2.2. Treatment for New Materials. The base and subbase material, as provided in the governing specifications, shall be delivered, placed and spread in the required amount per station. The material shall be manipulated as specified and thoroughly mixed prior to the addition of the asphalt base stabilization agent.

301.4.3.3. Asphalt Base Stabilization Agent Application. Asphalt base stabilization agent shall be spread only on that area where the mixing can be completed in the same working day. Asphalt base stabilization agent shall be mixed with water and applied as a thin water suspension. The distribution of asphalt stabilization agent at the rate shown on the plans shall be attained by successive passes over a measured surface of roadway until the proper moisture content and asphalt base stabilization agent content has been achieved.

The asphalt base stabilization agent shall be distributed at a uniform rate and in such a manner as to reduce heavy or light areas to a minimum. A motor grade can be used to cover the exposed asphalt base stabilization agent. If necessary, the material shall be sprinkled until a proper moisture content has been achieved.

301.4.3.4. Mixing. The application and mixing of asphalt base stabilization agent with the material shall be thorough. During the interval of time between application and mixing, asphalt base stabilization agent that has been exposed to the open air for a maximum time of 2-hours, or a shorter period when the breaking of the emulsion has occurred, shall not be accepted for payment. (Breaking of the emulsion is when the emulsion is over exposed on the surface without mixing, thus turning it from a brown color to black. The color change is due to the evaporation of the water from the emulsion, thus rendering it ineffective in mixing in the soil, base or subbase material). The CONTRACTOR is responsible for monitoring the application and the mix time of the asphalt stabilization agent with the soil, base or subbase material. The overexposed area shall be retreated with another application of asphalt base stabilization agent and mixed.

301.4.3.4.1. Treatment for Materials-In-Place. Material and asphalt base stabilization agent shall be thoroughly mixed by approved road mixers or other approved equipment and the mixing continued until a homogeneous, friable mixture of material and asphalt base stabilization agent is obtained, free from all clods or lumps. Materials containing plastic clay or other materials which shall not readily mix with asphalt base stabilization agent shall be mixed as thoroughly as possible, and meet the requirements of Table 301.4.3.4.1.(a) Asphalt Emulsion Treated Materials-In-Place when tested dry by laboratory sieve at the time of the asphalt base stabilization agent application, brought to the proper moisture content, sealed with a pneumatic roller, and left to cure 1 to 2 days as directed by the CITY. During the curing period, the material shall be kept moist.

Table 301.4.3.4.1.(a) Asphalt Emulsion Treated Materials-In-Place

Sieve Size	Minimum Passing by Dry Weight$_{1,2}$
1¾-in. (45mm)	100%
No. 4 (4.75mm)	60%

301.4.3.4.2. Treatment of New Material. The base or subbase material, asphalt base stabilization agent and required water shall be thoroughly mixed and blended by approved road mixers or other approved equipment and the mixing continued until a homogeneous, friable mixture is obtained. When the asphalt base stabilization agent is placed and mixed by the use of blades, the material shall be bladed as the asphalt base stabilization agent water mixture is applied; after the total amount has been placed, the mixture shall be thoroughly blended to the satisfaction of the CITY.

301.4.3.4.3. Central Mixing Plant. The soil, asphalt base stabilization agent and water shall be mixed in a pugmill either of the batch or continuous-flow type. The plant shall be equipped with feeding and metering devices which shall add the soil, asphalt base stabilization agent and water into the mixer in the specified quantities. Soil and asphalt base stabilization agent shall be mixed sufficiently to prevent asphalt base stabilization agent balls from forming when water is added. Mixing shall continue until a uniform and intimate mixture of soil, asphalt base stabilization agent and water is obtained. The mixture shall be placed on the moistened subgrade in a uniform layer by an approved spreader or spreaders.

After mixing asphalt stabilization agent with the base or subbase material the following conditions shall be met:

(1) Not more than 3-hours shall elapse between the placement of soil-asphalt emulsion mixture in adjacent lanes and placement at any location except at longitudinal construction joints.
(2) Not more than 3-hours shall elapse between the start of spreading the soil-asphalt emulsion mixture and start of compaction.
(3) Not more than 4-hours shall elapse between the start of mixing and the start of compaction.

The layer of soil-asphalt base stabilization agent shall be uniform in thickness and surface contour, and in such quantity that the completed base shall conform to the required grade and cross section. Dumping of the mixture in piles or windrows upon the subgrade shall be permitted.

301.4.3.5. Compaction. Compaction of the mixture shall begin immediately after final mixing and in no case later than 2-days after final mixing. The material shall be aerated or sprinkled as necessary to provide optimum moisture content. At the start of compaction, the moisture in the mixture and in unpulverized soil lumps, based on oven-dry weights, shall be within minus-2- to plus-2-percent-of-optimum. The specified optimum moisture content and density shall be determined in the field on the representative samples of soil-asphalt base stabilization agent mixture obtained from the area being processed. Prior to the beginning of 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 4-hours. Compaction shall begin at the bottom and shall continue until the entire depth of the mixture is uniformly compacted as shown on the plans or specified by the CITY.

The compacted mixture shall have a uniform density of not less than 95-percent of the maximum density as determined by ASTM D698 Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ftlbf/ft_3 (600 kN-m/m_3)). Final moisture content shall be within minus-2- to plus-4-percent-of-optimum. If the soilasphalt base stabilization agent mixture is wetted by rain so that the average moisture content exceeds the tolerance given at the time of final compaction, the entire section shall be reconstructed in accordance with this specification at the sole expense of the CONTRACTOR. After the soil and asphalt base stabilization agent mixture, except the top layer, is compacted, water shall be uniformly applied as needed and thoroughly mixed in with a spike tooth harrow or equal. The surface shall then be reshaped to the required lines, grades and cross sections and then lightly scarified to loosen any imprint left by the compacting or shaping equipment. After each section is completed, such tests as are necessary shall be made by the CITY. If any portion fails to meet the density specified, it shall be reworked as necessary to obtain the specified density at the sole expense of the CONTRACTOR.

301.4.3.6. Finishing, Curing and Preparation for Surfacing. The resulting surface shall be thoroughly rolled with a pneumatic tire roller and “clipped”, “skinned”, and “tight-bladed” by a power grader to a depth of approximately ¼-in. (6mm), moving all loosened soil and asphalt base stabilization agent from the section. The surface shall then be thoroughly compacted with the pneumatic roller, adding small increments of moisture as needed during rolling. When directed by the CITY, surface finishing methods maybe varied from this procedure, provided a dense, uniform surface, free of surface material, is maintained at its specified optimum during all finishing operations. Surface compaction and finishing shall proceed in such a manner as to produce, in not more than 4-hours, a smooth, closely knit surface, free of cracks, ridges or loose material, conforming to the drawn grade and line shown on the plans.

The completed section shall then be moist-cured for a minimum of 2-days before further courses are added, unless otherwise directed by the CITY. In cases where, in the opinion of the Engineer, subgrade treatment or subbase sets up sufficiently to prevent objectionable damage from traffic, such layers may be opened to traffic after compaction. The surface of the compacted layer shall be kept moist until covered by other base or paving material or application of a curing seal of emulsified asphalt. If a curing seal is used, it shall be applied as soon as possible after completion of final rolling, at a rate of between 0.10- and 0.20-gallons-persquare-yard (0.5- to 1.0-liters-per-m_2), the exact rate to be determined by the CITY. No equipment or traffic shall be permitted on asphalt base stabilization agent treated material for 12-hours after curing seal is applied, unless otherwise permitted by the CITY.

301.4.3.7. Maintenance. The CONTRACTOR shall be required to maintain the completed asphalt stabilized base within the limits of its contract in good condition, satisfactory to the CITY as to grade, crown and cross section until such time as the surface course is constructed. The CONTRACTOR shall immediately repair all irregularities or other defects that may occur at the CONTRACTOR'S expense. Repairs are to be made as directed by the CITY and in a manner to insure restoration of a uniform surface and durability of the portion repaired.

301.5. FLEXIBLE SUBBASE OR BASE (CRUSHED STONE/CONCRETE)

This item shall consist of a foundation course for a surface course or for other subbase or base courses; shall be constructed as herein specified in one or more courses in conformity with the typical section shown on the plans and to the lines and grades as established by the CITY.

301.5.1. Material.

301.5.1.1. General. Should the CONTRACTOR elect to produce the material from local pits, the material shall be secured from sources approved by the CITY. The pits as utilized shall be opened up in such a manner as to immediately expose the vertical faces of all the strata of acceptable material in depth mined. Unless

otherwise directed, the material shall be secured in successive vertical cuts extending through all of the exposed strata, in order that a uniform mixed material shall be secured.

301.5.1.2. **Tests and Physical Requirements**. Tests shall be performed in accordance with ASTM D4318 Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils. The preparation of samples for testing according to ASTM D4318 shall be in accordance with the requirements of ASTM D2217 Practice for Wet Preparation of Soil Samples for Particle-Size Analysis and Determination of Soil Constants. The material shall also be tested under TxDOT Test Method Tex-116-E The Wet Ball for Determining the Disintegration of Flexible Base Materials. The City may decide to accept the LA Abrasion Test (ASTM C 131) instead of the Wet Ball Mill test. When a magnesium soundness value is shown on the plans the material shall be tested in accordance with Test Method Tex-411-A Soundness of Aggregate Using Sodium Sulfate or Magnesium Sulfate. Physical properties shall meet the requirements in Table 301.5.1.2.(a) Flexible Base or Subbase Material Requirements, according to specified grade.

Table 301.5.1.2.(a) Flexible Base or Subbase Material Requirements

Property	Grade 1		Grade 2	
Triaxial Class	1 1 to 2.3		1 1 to 2.3	
Minimum Compressive Strength at at lateral pressure 0-psi at lateral pressure 15-psi (1.1 kg/cm2)	45-psi (3.2-kg/cm2) 175-psi (12.3-kg/cm2)		35-psi (2.5-kg/cm2) 175-psi (12.3-kg/cm2)	
Master Grading	Sieve	Percent Retained	Sieve	Percent Retained
	1¾” 7/8" 3/8" No. 4 No. 40	0 10-35 30-50 45-65 70-85	2½" 1¾" No. 4 No. 40	0 0-10 45-75 60-85
Maximum Liquid Limit	35		40	
Maximum Plasticity Index	10		12	
Maximum Wet Ball Mill [1,2]	40		45	
Maximum increase in passing No. 40	20%		20%	
Maximum foreign material allowed	1%		1%	

1. When lightweight aggregates are used, the wet ball mill requirements shall not apply; lightweight aggregate shallmeet the Los Angeles Abrasion, Pressure Slaking and Freeze Thaw requirements of TxDOT Item 303 Aggregate for Surface Treatment (Lightweight).
2. When using the LA Abrasion instead of the Wet Ball Mill, the material shall have no more than 50% wear or loss after 500 revolutions per ASTM C 131. Such tests shall be verified by an independent testing laboratory, not by the material supplier.

301.5.1.3. Material Testing. Crushed limestone base used in city streets shall have documentation available from an independent testing laboratory confirming compliance with the requirements noted in this Design and Development Standards Manual. The City may require a test at any time during construction, at City expense, except failed tests shall be at the Contractor’s expense.

301.5.2.1. Preparation of Subgrade. Preparation of the subgrade shall be in conformity with the requirements of Item 301.3.3.3.1. Subgrade Preparation.

301.5.2.2. Placing. Immediately before placing the subbase or base course material, the subgrade shall be checked as to conformity with grade and section.

The material shall be delivered in approved vehicles of a uniform capacity. It shall be the charge of the CONTRACTOR that the required amount of specified material shall be delivered to secure the proper thickness of the completed subbase or base course. Material deposited on the subgrade shall be spread and shaped the same day. All material shall be moved at least once from the original position in which it is deposited. In the event of inclement

weather or other unforeseen circumstances which render impracticable the spreading of the material during the first 24-hour period, the material shall be scarified and spread as directed by the CITY. The material shall be sprinkled, if directed, and shall then be bladed, dragged and shaped to conform to the typical section as shown on the plans.

All areas and "nests" of segregated coarse or fine material shall be corrected or removed and replaced with well-graded material as directed by the CITY. If additional binder is considered desirable or necessary after the material is spread and shaped, it shall be furnished and fully incorporated with the material in place by scarifying, harrowing, brooming or by other approved methods. The course shall be sprinkled as required and compacted to the extent necessary to provide not less than the percent density as specified in Item 301.5.2.3.

Density. In addition to the requirements specified for density, the full depth of flexible subbase or base shown on the plans shall be compacted to the extent necessary to remain firm and stable under construction equipment. After each course is completed, tests as necessary shall be made by the CITY unless otherwise specified in the special provisions or in the plans. If the material fails to meet the density requirements, it shall be reworked as necessary to meet these requirements.

Throughout the entire operation, the shape of the course shall be maintained by blading. The surface, upon completion, shall be smooth and in conformity with the typical sections shown on the plans to the established lines and grades. On the surface on which pavement is to be placed, any deviation in excess of ½-in. in cross section in a length of 16-ft. (13mm in 5m) measured longitudinally shall be corrected by loosening, adding or removing material, reshaping and recompacting by sprinkling and rolling. All fractures, settlement, or segregation that develops shall be corrected immediately by scarifying the areas affected, adding suitable material as required, reshaping and recompacting by sprinkling and rolling.

Should the subbase or base course, due to any reason or cause, lose the required stability, density and finish before the surfacing is complete, it shall be recompacted and refinished at the sole expense of the CONTRACTOR.

301.5.2.3. Density. The density required under this item shall not be less than 95-percent compaction as determined by ASTM D1557, Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3)). Moisture content shall be within minus-2- to plus-4-of-optimum.

301.5.2.4. Courses. Non full depth asphalt pavements, paving types with flexible base under the curb and gutter shall be placed and compacted at the same time and in the same operation as the flexible base under the pavement. Where the subbase or base course exceeds 6-in. (15cm) in thickness, it shall be constructed in two or more courses of equal thickness as indicated on the typical section. A minimum course depth of 3-inches is recommended. The first course shall be placed and compacted under the curb and gutter and under the pavement. The curb and gutter shall then be built upon the first course. The final course of the flexible base shall be placed following the curing time as specified in Item 305.1. Concrete Curb and Gutter.

301.6. GEOTEXTILES USED IN PAVING APPLICATIONS

301.6.1. Materials.

301.6.1.1. Physical Properties. The fabric properties shall conform to those shown in Table 301.6.1.(a) Geotextiles for Paving, as determined by the Federal Highway Administration Task Force 25 Guidelines using ASTM Test Methods, except where noted.

301.6.1.2. Certification. The manufacturer, if required by the CITY, shall provide documents stating the name and manufacturer, the chemical composition of the filaments or yarns and test values of the properties of the geotextile. The manufacturer must certify that the material meets or exceeds these specifications.

301.6.1.3. Rejection. Geotextile may be rejected for failure to meet any of the requirements of this specification.

Table 301.6.1.(a) Geotextiles for Paving

Designation (Test Method)	Characteristic	Average Roll Minimum Value
ASTM D4632 Grab Breaking Load and Elongation of Geotextiles	Grab Strength	80-lbs. @ 12-in.-per-minute (36.3kg @ 30.5-cm/min)
ASTM D4632	Elongation @ Break	50% @ 12-in.-per-minute (30.5-cm/min)
Tex-616-J, Construction Fabrics	Asphalt Retention	0.5-oz.-per-sq.-ft. (0.15-kg/m^2)
ASTM D276 Identification of Fibers in Textiles	Melting Point	300°F (150°C)

301.6.2. Construction Methods. Construction methods for each type unit shall be provided by the manufacturer and approved by the CITY based on the site-specific use.

ITEM 302. ASPHALT PAVEMENT

302.1. DESCRIPTION

This Item establishes the requirements for asphalt construction. This Item includes material requirements and construction methods for emulsified asphalts, hot-mix asphalt pavement, performance graded (PG) asphalts and other miscellaneous asphaltic materials and polymer additives. Refer to Table 302.1.1 for minimum asphalt installation.

302.2. AGGREGATES FOR HOT-MIX ASPHALT PAVEMENT

302.2.1. General Requirements. Aggregates shall conform to the requirements contained in this Item 302.2. Aggregates for Hot-Mix Asphalt Pavement and shall be approved by the CITY prior to use. The integrity of the aggregate shall be such as to produce a workable material within the limits contained in this specification.

302.2.1.1. Deleterious Substances. Aggregates shall be free from loam, clay balls or other injurious foreign matter occurring either free or as a coating on the aggregates.

302.2.1.2. Storage. Prior to stockpiling of aggregates, the area shall be cleaned of trash, weeds and grass and be relatively smooth. Aggregates shall be stockpiled in such a manner as to prevent mixing of one aggregate with another. Coarse aggregates shall be separated into stockpiles of different gradation, such as a large coarse aggregate and a small coarse aggregate stockpile and such that the grading requirements of the specified type shall be met when the piles are combined in the asphaltic mixture. No coarse aggregate stockpile shall contain more than 15-percent by weight of material that shall pass a No. 10 (2.0mm) sieve except as noted on the plans. Fine aggregate stockpiles may contain coarse aggregate in the amount of up to 20-percent by weight; however, the coarse aggregate shall meet the quality tests specified in Item 302.2.2. Coarse Aggregates. Suitable equipment of acceptable size shall be furnished by the CONTRACTOR to work the stockpiles and prevent segregation of the aggregates.

302.2.1.3. Quality and Testing Requirements. Test of aggregates, when required, shall be made in accordance with applicable Texas Department of Transportation tests or ASTM Test Methods, as shown in the tables below or as required by CITY.

Requirements for hot-mix asphalt pavement aggregates are shown in Table 302.2.2.(a) Aggregate Quality Requirements.

302.2.1.4. Aggregate Rejection. Aggregates that fail to meet the requirements of these specifications may be rejected by the CITY. Such rejection shall incur no cost to the CITY. The CITY may reject sources from which materials are delivered with properties not meeting these specifications. Such rejection shall incur no cost to the CITY.

302.2.2. Coarse Aggregates. Coarse aggregates shall be that portion of the total aggregates retained on the No. 10 sieve (2.0mm). Coarse aggregates shall consist of clean, tough, durable fragments of crushed stone, crushed gravel, or steel slag as specified herein, of uniform quality throughout.

All coarse aggregates shall meet the requirements listed in Table 302.2.2.(a) Coarse Aggregate Quality Requirements.

Table 302.2.2.(a) Coarse Aggregate Quality Requirements[1]

Characteristic	Test Method	Value
Deleterious Material	Tex-217-F, Part I, Determining Deleterious Material in Coarse Aggregates (Bituminous Mixtures)	1.5% Max.
Decantation	Tex-217-F, Part I I, Decantation Test for Coarse Aggregate (Bituminous Mixtures)	1.5% Max.
Los Angeles Abrasion	Tex-410-A, Abrasion of Coarse Aggregate Using the Los Angeles Machine (ASTM C131)	35% Max.
Magnesium Sulfate Soundness Loss, 5 Cycle	Tex-411-A, Soundness of Aggregate Using Sodium Sulfate or Magnesium Sulfate	30% Max. (lower value may be shown on plans)
Coarse Aggregate Angularity Two Crushed Faces	Tex-460-A, Part I, Determining Crushed Face Count	90% Min.
Flat Elongated Particles	ASTM D4791 Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate	20% Max. @ 3:1

1. Sampled during delivery to the plant or from the stockpile, unless otherwise shown on the plans.

Table 302.1.1 HMAC INSTALLATION/TESTING REQUIRMENTS

	Width	Wheel Loading Design	Plant Control	Field Test	Location of Test	Frequency
Alley	20	20,000.00	Yes	Nuclear	City	City
Local Street/Culdesac	31	20,000.00	Yes	Nuclear	City	City
Collector Street	36	100,000.00	Yes	Core	City	City
Arterial Street	49	400,000.00	Yes	Core	City	City
Major Thoroughfare	60	500,000.00	Yes	Core	City	City

Asphalt Testing Method

Marshall (50 Blows)

Nuclear Testing Requirement

Lab Compacted Minimum – 95% Compaction

Core Testing Requirement

Lab Compacted Minimum – 95% Compaction

Hot Mix Sample Location

(For Gradation, Oil Content and Specific Gravity)

* Preferred Location: Plant
Alternate Location #1: Truck
Alternate Location #2: Laydown Hopper

* Note: City Determines Sample Extracting Location

Collector Streets, Arterial Streets And /Or Major Thoroughfares Less Than Or Equal To 200 Tons

Must Use Local Street Requirements

HMAC Mix Design Submittal To City

Annually or Annual Verification

302.2.3. Fine Aggregate. Fine aggregate may consist of crushed stone, crushed gravel, sand, and/or limestone or steel slag screenings.

Fine aggregate shall meet the requirements listed in Table 302.2.3.(a) Fine Aggregate Quality Requirements.

Table 302.2.3.(a) Fine Aggregate Quality Requirements[1]

Characteristic	Test Method	Value
Linear Shrinkage	Tex-107-E, Determining the Bar Linear Shrinkage of Soils	3% Max.
Sand Equivalent Value	Tex-203-F, Sand Equivalent Test	45 Min.

1. Sampled during delivery to the plant or from the stockpile, unless otherwise shown on the plans.

302.2.3.1. Sand. Sand material may constitute a part of the fine aggregates for hot-mix asphalt pavement. The fine aggregate portion of the sand passing the No. 40 (425-um) sieve shall meet the Linear Shrinkage requirement listed in Table 302.2.3.(a) Fine Aggregate Quality Requirements.

302.2.3.1.1. Gradation. Fine aggregate sand shall be that portion of the sand in the total aggregate passing the No. 10 (2.0mm) sieve. It shall be well graded and composed of sound, durable sand particles.

302.2.3.2. Limestone or Steel Slag Screenings. Limestone or steel slag screenings may constitute part or all of the fine aggregates for hot-mix asphalt pavement. Screenings shall be of the same or similar material for coarse aggregates. Where limestone rock screenings are specified for use, they shall be screenings resulting from crushing operation.

The fine aggregate portion passing the No. 40 (425-um) sieve shall meet the Linear Shrinkage requirement listed in Table 302.2.3.(a) Fine Aggregate Quality Requirements. Fine aggregates from each source shall meet Linear Shrinkage requirements.

302.2.3.2.1. Gradation. The limestone or steel slag screening shall meet the grading requirements in Table 302.2.3.2.1.(a) Limestone or Steel Slag Screenings Gradation unless otherwise shown on the plans.

When authorized by the CITY, stone or steel slag screenings containing particles larger than ~-in. (9.5-mm) may be used but only that portion of the material passing the ~-in. (9.5-mm) sieve shall be considered as fulfilling the requirements for screenings when a minimum percent of screenings is specified for a particular mixture.

Table 302.2.3.2.1.(a) Limestone or Steel Slag Screenings Gradation

Sieve Size	Percent Passing by Weight
~-in. (9.5-mm)	100
Passing No. 200 (75-um)	0 to 30

302.2.4. Mineral Filler. Mineral filler shall consist of a thoroughly dry stone dust Portland cement or other mineral dust approved by the CITY. All mineral filler shall meet the requirements listed in Table 302.2.4.(a) Mineral Filler Quality Requirements.

Table 302.2.4.(a) Mineral Filler Quality Requirements[1]

Characteristic	Test Method	Value
Linear Shrinkage	Tex-107-E, Determining the Bar Linear Shrinkage of Soils	3% Max.

1. Sampled during delivery to the plant or from the stockpile, unless otherwise shown on the plans.

302.2.4.1. Gradation. When tested by the method outlined in TxDOT Test Method Tex-200-F Sieve Analysis of Fine and Coarse Aggregates (Part 1 Dry Sieve Analysis (Based on Weight) or Part 3 Volumetric Sieve Analysis, as applicable), it shall meet the requirements of Table 302.2.4.1.(a) Mineral Filler Gradation.

Table 302.2.4.1.(a) Mineral Filler Gradation

Sieve Size	Percent Passing by Weight
No. 30 sieve (600-um)	95 to 100
No. 80 sieve (180-um)	Not Less Than 75
No. 200 sieve (75 um)	Not Less Than 55

302.3. BITUMINOUS MATERIALS

302.3.1. General. This Item consists of bituminous material, including performance graded asphalts, modified performance graded asphalts, asphalt cement, emulsified asphalt, and other miscellaneous asphaltic materials. Asphalt for use in paving shall be a refined asphalt produced from crude petroleum. The base asphalt shall be homogeneous and free from water and residue from distillation of coal, coal tar or paraffin oil and shall not foam when heated to 347°F (175°C).

302.3.1.1. Tests and Certification of Bituminous Materials. When tested according to ASTM or AASHTO test methods, the various materials shall meet the applicable requirements of this specification. At the time of delivery of each shipment of asphalt, the vendor supplying the material shall deliver to the CONTRACTOR certified copies of the test report. Two copies of the test reports shall be furnished to the CITY. Test reports shall indicate the name of the vendor, type and grade of bituminous material delivered, date and point of delivery, quantity delivered, delivery ticket number, purchase order number, and results of the specified tests. The test report, signed by an authorized representative of the vendor, shall certify that the product delivered conforms to the specifications for the type and grade indicated. The certified test reports and the testing required in connection with the reports shall be at no cost to the CITY.

Until the certified test reports and samples of the material have been checked by the CITY to determine their conformity with the prescribed requirements, the material to which such report relates and any work in which it may have been incorporated as an integral component, shall be only tentatively accepted by the CITY. Final acceptance shall be dependent upon the determination by the CITY that the material involved fulfills the prescribed requirements.

302.3.1.2. Rejection. Any material specified in this section may be rejected for failure to meet any of the provisions for this specification, or for any defect causing it to be unsuitable for its intended use.

302.3.2. Performance Graded (PG) Asphalt Binders. Performance graded asphalt binders shall be smooth and homogeneous, shall be free from water, shall not foam when heated to 347°F (175°C) and shall meet the requirements for performance graded asphalt binders shown in Table 302.3.2.(a) Performance Graded Asphalt Binders.

PG binders shall show no separation when tested according to Tex-540-C Measurement of Polymer Separation on Heating in Modified Asphalt Systems. Separation testing is not required if one of the following conditions is met:

(1) The modifier is introduced separately at the mix plant either by injection in the asphalt line or mixer; or
(2) The binder is blended on site in continuously agitated tanks; or
(3) Binder acceptance is based on field samples taken from an in-line sampling port at the hot-mix plant after the addition of modifiers.

302.3.2.1. Modified Performance Graded Asphalt Binders. In addition to meeting the requirements in Table 302.3.2.(a) Performance Graded Asphalt Binders, modified performance graded asphalt binders shall also meet the requirements listed herein according to grade.

302.3.2.1.1. SBR Latex Rubber Modified Performance Graded Binders. Available grades include PG 64-28L, PG 70-28L, PG 70-22L, PG 76-22L, AND PG 82-22L. The manufacturer shall provide certification that SBR latex rubber was used in production of the binder. Ductility tested according to AASHTO T51: 39.2°F, 1-cm/min, cm, 70-cm minimum.

302.3.2.1.2. SBS Rubber Modified Performance Graded Binders. Available grades include PG 64-28S, PG 70-28S, PG 70-22S, PG 76-22S, AND PG 82-22S. The manufacturer shall provide certification that SBS rubber was used in production of the binder. Elastic recovery tested according to Tex-539-C Measurement of Elastic Recovery of Tensile Deformation Using a Ductilometer: 50°F, 55% minimum.

302.3.2.1.3. Tire Rubber Modified Performance Graded Binders. Available grades include PG 64-28TR, PG 70-28TR, PG 70-22TR, PG 76-22TR, and PG 82-22TR. The manufacturer shall provide certification that tire rubber was used in production of the binder. Elastic recovery tested according to Tex-539-C Measurement of Elastic Recovery of Tensile Deformation Using a Ductilometer: 50°F, 40% minimum.

302.3.2.1.4. Multigrade Modified Performance Graded Binders. Available grades include PG 64-28MG, PG 70-28MG, PG 70-22MG, PG 76-22MG, and PG 82-22MG. The manufacturer shall provide certification that gelling agent was used in production of the binder. Float test made according to AASHTO T50: 140°F, seconds, 1200 minimum.

Table 302.3.2.(a) Performance Graded Asphalt Binders

Performance Grade	PG 58			PG 64				PG 70				PG 76				PG 82		
	-22	-28	-34	-16	-22	-28	-34	-16	-22	-28	-34	-16	-22	-28	-34	-16	-22	-28
Average 7-day maximum Pavement Design Temperature, °C[1]	58			64				70				76				82		
Minimum Pavement Design Temperature, °C[1] (i.e. design temperature shall be	-22	-28	-34	-16	-22	-28	-34	-16	-22	-28	-34	-16	-22	-28	-34	-16	-22	-28
Original Binder																		
Flash Point Temperature, AASHTO T48: Minimum °C	230																	
Viscosity, AASHTO TP48[2,3] Maximum, 3.0 Pa*s, Test Temp, °C	135																	
Dynamic Shear, AASHTO TP5[4]: G*/sinä, Minimum, 1.00-kPa Test Temperature @ 10-rad/s, °C	58			64				70				76				82		
Rolling Thin Film Oven (Tex-541-C)																		
Maximum Loss, percent	1.0																	
Dynamic Shear, AASHTO TP5: G*/sinä, Minimum, 2.20-kPa Test Temperature @ 10-rad/s, °C	58			64				70				76				82		
Pressure Aging Vessel Residue (AASHTO PP1)																		
PAV Aging Temperature, °C	100																	
Dynamic Shear, AASHTO TP5: G*/sinä, Maximum, 5000-kPa Test Temperature @ 10-rad/s, °C	25	22	19	28	25	22	19	28	25	22	19	28	25	22	19	28	25	22
Creep Stiffness, AASHTO TP1[5,6]: S, Maximum, 300-Mpa m-value, Minimum, 0.300 Test Temp @60s, °C	-12	-18	-24	-6	-12	-18	-24	-6	-12	-18	-24	-6	-12	-18	-24	-6	-12	-18
Direct Tension, AASHTO TP3[6]: Failure Strain, Minimum, 1.0%	-12	-18	-24	-6	-12	-18	-24	-6	-12	-18	-24	-6	-12	-18	-24	-6	-12	-18

1. Pavement temperatures are estimated from air temperatures using an algorithm contained in the PGEXCEL3.XLS software program, may be provided by the specifying agency, or by following the procedures as outlined in AASHTO MP2 and PP28.
2. This requirement may be waived at the discretion of the specifying agency 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 (AASTHO T201 or T202) or rotational viscometry (AASHTO TP48).
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 mixing and compaction operations. CONTRACTORS are therefore responsible for addressing any constructability issues which may arise.
4. For quality control of unmodified asphalt cement production, measurement of the viscosity of the original asphalt cement may be substituted for dynamic shear measurements of G*/sin(ä) at test temperatures where the asphalt is a Newtonian fluid. Any suitable standard means of viscosity measurement may be used, including capillary (AASHTO T201 or T202) or rotational viscometry (AASHTO TP48).
5. Silicone beam molds as described in AASHTO TP1-93 are acceptable for use.
6. If the creep stiffness is below 300-Mpa, the direct tension test is not required. If the creep stiffness is between 300- and 600-Mpa, the direct tension failure strain requirement can be used in lieu of the creep stiffness requirement. The m-value requirement must be satisfied in both cases.

302.3.2.2. Acceptance of Performance Graded (PG) Asphalt Binders.

302.3.2.2.1. Location of Manufacture. Performance graded binder acceptance procedures are dependant on where the binder is manufactured. The requirements are as follows.

Manufactured at the Source. PG binders manufactured at the source are normally approved at the

source according to the applicable requirements of the CITY. The CITY may acquire field samples at any time, particularly if material quality is suspect.

Manufactured at the Job Site. If PG binders are manufactured at the job site, for example where SBR latex is injected at the hot mix plant, the following quality measures are required. Antistrip agents are not considered asphalt modifiers.

(1) Preconstruction. The CONTRACTOR shall provide the CITY with a 1-quart sample of the proposed binder and a test report showing compliance with the required performance grade. The sample and test report will be forwarded to CITY for verification testing. If the CITY chooses to verify that the sample meets specifications, the CITY will complete verification testing within ten (10) working days after receipt of the sample. If the CITY chooses to verify the sample, then the sample shall be verified before mixture production is allowed to begin.

(2) Construction. A sampling port is required which meets the requirements of AASHTO T40 Practice for Sampling Bituminous Materials, Section 9, “Sampling From Pipelines During Loading or Unloading”. This sampling port shall be located on the asphalt line before introduction of the asphalt into the mix plant and shall be downstream from the addition of any modifiers and any dispersing or mixing equipment associated with their introduction.

Sample containers shall be provided by the CONTRACTOR and shall be clean, double friction top round 1-quart cans. All samples shall be taken by the CONTRACTOR, and witnessed by the Engineer.

All samples shall be taken from the sampling port after a sufficient amount of asphalt is run out and wasted, in order to clear any residual asphalt that builds up in the sampling port. All samples shall be taken in a clean, 1-gallon can, immediately stirred and used to fill three (3) 1-quart sample cans. The cans shall be delivered to the CITY. The CITY will choose one sample can for testing and the other cans are retained until testing is complete, in case the original sample is lost or damaged.

302.3.2.2.2. Sampling Frequency. A sample of the PG binder may be taken from each mixture production day, at a time determined by the CITY. The sample from the first day’s production may be subjected to verification testing. Additionally, throughout the duration of the project, the CITY may randomly select binder samples for verification testing.

302.3.2.2.3. Verification Testing. CITY may perform verification testing on all construction samples. The CITY will complete verification testing within 10 working days after receipt of the sample.
For verification testing which fails to confirm the required performance grade, the CONTRACTOR shall review the manufacturing process to locate the source of the problem. The CITY may stop production until the CONTRACTOR can show that the next binder produced will meet the specifications. The CITY may require materials not meeting the specification requirements to be removed and replaced at the CONTRACTOR's expense.

302.3.3. Asphalt Cement. Asphalt cement is bituminous liquid binder. The material for asphalt cement shall be homogeneous, shall be free from water, shall not foam when heated to 347°F (175°C) and shall meet the requirements of Table 302.3.3.(a) Requirements for Asphalt Cement.

Table 302.3.3.(a) Requirements for Asphalt Cement

Property, Test Parameters	Value According to Grade							
		AC-3		AC-5	AC-10		AC-20	
	Min	Max	Min	Max	Min	Max	Min.	Max
Viscosity, 140°F (60°C), Stokes	250	350	400	600	800	1200	1600	2400
Viscosity, 275°F (135°C), Stokes	1.1	—	1.4	—	1.9	—	2.5	—
Penetration, 77°F, (25°C) 100-g, 5-sec.	210	—	135	—	85	—	55	—
Flash point C.O.C., °F(°C)	425 (220)	—	425 (220)	—	450 (230)	—	450 (230)	—
Solubility in trichloroethylene (%)	99.0	—	99.0	—	99.0	—	99.0	—
Tests on residues from thin film oven test: Viscosity, 140°F (60°C), Stokes	—	900	—	1500	—	3000	—	6000
Ductility, 77°F (25°C) 5-cms-per-min, cms.	100	—	100	—	70	—	50	—
Spot Test	Negative for all grades							

302.3.3.1. Polymer Modified Asphalt Cement. For surface treatment applications, a polymer additive consisting of an anionic emulsion of styrene-butadiene low-temperature copolymer shall be added to the AC-5 or AC-10 asphalt when specified on the plans or in the specifications in the contract. The polymer additive shall consist of two-percent (by weight) polymer additive (solids basis) which has good storage stability. Polymer additive shall possess the properties specified in Item 302.3.3.1.1. Polymer Additive Properties. The manufacturer shall furnish the actual styrene-butadiene rubber (SBR) content for each batch of polymer emulsion. This information shall accompany all shipments to facilitate proper addition rates.

The finished polymer modified asphalt cement blend shall be smooth, homogeneous, and comply with the requirements in Table 302.3.3.1.(a) Polymer Modified Asphalt Requirements.

Table 302.3.3.1.(a) Polymer Modified Asphalt Requirements

Property	Test Method, Test Parameters	Value According to Grade	
		AC-5 + 2% Polymer Solids	AC-10 + 2% Polymer Solids
Minimum SBR Content	Tex-533-C Determining Polymer Additive Percentages in Polymer Modified Asphalt Cements, IR Determination[1]	2.0% Solids By Wt.	2.0% Solids By Wt.
Penetration	AASHTO T49, 100-G, 5-Sec, 77°F	120 Min	80 Min
Minimum Viscosity	AASHTO T202, 140°F	700-Poise	1300-Poise
Maximum Viscosity	AASHTO T202, 275°F	7.0-Poise	8.0-Poise
Ductility	AASHTO T51, 39.2°F, 5-cm/Min	70-cm, Min	60-cm, Min
Separation of Polymer	Tex-540-C Measurement of Polymer Separation on Heating in Modified Asphalt Systems, After 48-Hrs. at 325°F	None	None

1. The asphalt supplier shall furnish the CITY samples of the asphalt cement and polymer emulsion used in making the finished product.

302.3.3.1.1. Polymer Additive Properties. The polymer additive shall be an emulsion of styrene-butadiene low-temperature copolymer in water. The emulsion shall have good storage stability and possess the properties in Table 302.3.3.1.1.(a) Polymer Additive Requirements.

Table 302.3.3.1.1.(a) Polymer Additive Requirements

Property	Value
Monomer Ratio of Polymer (butadiene to styrene)	73 ± 5
	27± 5
Minimum Solids Content (percent by weight)	45
Viscosity of Emulsion at 77 ± 1°F, cps, max (No.3 spindle, 20-rpm, Brookfield RVT Viscometer)	2000

302.3.4. Emulsified Asphalt. Emulsified asphalt shall be composed of a paving asphalt base uniformly emulsified with water. It shall be homogeneous throughout and, when stored, shall show no separation within 30-days after delivery. Emulsified asphalt shall meet the requirements for the specified type and grade shown in Tables 302.3.4.(a) through (d).

302.3.4.1. Testing Requirements. Test reports and certification shall be made for emulsified asphalt in accordance with Item 302.3.1.1. Tests and Certification of Bituminous Materials.

302.3.4.2. Temperature. Emulsified asphalt may be reheated, but at no time after loading for transportation from refinery to the purchaser shall the temperature of the emulsion be raised above 160°F (70°C). During reheating, the emulsified asphalt shall be agitated to prevent localized overheating. Emulsified asphalt shall not be permitted to cool to a temperature of less than 40°F (4°C). Unless otherwise specified, emulsified asphalt shall be applied at a temperature within the limits specified in Table 302.5.(a) Requirements for Storage, Heating and Application Temperature. CONTRACTOR shall furnish and keep on the site an accurate thermometer suitable for determining the temperature of the emulsified asphalt.

Table 302.3.4.(a). Tests and Properties of Anionic Emulsions

Property	Rapid Setting				Medium Setting		Slow Setting			
	Type - Grade									
	RS-2		RS-2h		MS-2		SS-1		SS-1 h	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Viscosity, Saybolt Furol at 77°F, sec	-	-	-	-	-	-	20	100	20	100
at 122°F, sec	150	400	150	400	100	300	-	-	-	-
Sieve Test, %	-	0.10	-	0.10	-	0.10	-	0.10	-	0.10
Miscibility (Standard Test)	-	-	-	-	-	-	Passing		Passing	
Cement Mixing, %	-	-	-	-	-	-	-	2.0	-	2.0
Demulsibility, 35-ml of 0.02 N $CaCl_2$, %	60	-	60	-	-	30	-	-	-	-
Storage Stability, 1-day, %	-	1	-	1	-	1	-	1	-	1
Freezing Test, 3 cycles[1]	-	-	-	-	Passing		Passing		Passing	
Distillation Test:										
Residue by Distillation, % by weight	65	-	65	-	65	-	60	-	60	-
Oil Distillate, % by volume of emulsion	-	½	-	½	-	½	-	½	-	½
Tests on Residue from Distillation:										
Penetration at 77°F, 100 g, 5 sec	120	160	80	110	120	160	120	160	70	100
Solubility in Trichloroethylene, %	97.5	-	97.5	-	97.5	-	97.5	-	97.5	-
Ductility at 77°F, 5 cm/min, cm	100	-	80	-	100	--	100	-	80	-

1. Applies only when the Engineer designates material for winter use.

Table 302.3.4.(b). Tests and Properties of High Float Anionic Emulsions

Property	Rapid Setting		Medium Setting	
	Type - Grade			
	HFRS-2		AES-300	
	Min	Max	Min	Max
Viscosity, Saybolt Furol at 77°F, sec	-	-	75	400
at 122°F, sec	150	400	-	-
Sieve Test, %	-	0.10	-	0.10
Coating Ability and Water Resistance:				
Coating, dry aggregate	-	-	good	
Coating, after spraying	-	-	fair	
Coating, wet aggregate	-	-	fair	
Coating, after spraying	-	-	fair	
Demulsibility 35-ml of 0.02 N $CaCl_2$, %	50	-	-	-
Storage Stability Test, 1-day, %	-	1	-	1
Distillation Test:				
Residue by Distillation, % by weight	65	-	65	-
Oil Distillate, by volume of emulsion, %	-	1/2	-	5
Tests on Residue from Distillation:				
Penetration at 77°F, 100 g, 5 sec	100	140	300	-
Solubility in Trichloroethylene, %	97.5	-	97.5	-
Ductility at 77°F, 5 cm/min, cm	100	-	-	-
Float Test at 140°F, sec	1200	-	1200	-

Table 302.3.4.(c). Tests and Properties of Cationic Emulsions

Property	Rapid Setting				Medium Setting				Slow Setting			
	Type - Grade											
	CRS-2		CRS-2h		CMS-2		CMS-2s		CSS-1		CSS-1 h	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Viscosity, Saybolt Furol												
at 77°F, sec	-	-	-	-	-	-	-	-	20	100	20	100
at 122°F, sec	150	400	150	400	100	300	100	300	-	-	-	-
Sieve Test, %	-	0.10	-	0.10	-	0.10	-	0.10	-	0.10	-	0.10
Cement Mixing, %	-	-	-	-	-	-	-	-	-	2.0	-	2.0
Demulsibility, 35 ml 0.8 percent sodium dioctyl sulfosuccinate, %	40	-	40	-	-	-	-	-	-	-	-	-
Storage Stability, 1 day, %	-	1	-	1	-	1	-	1	-	1	-	1
Coating Ability and Water Resistance:												
Coating, dry aggregate	-	-	-	-					-	-	-	-
Coating, after spraying	-	-	-	-	good		good		-	-	-	-
Coating, wet aggregate	-	-	-	-	fair		fair		-	-	-	-
Coating, after spraying	-	-	-	-	fair		fair		-	-	-	-
Particle Charge Test	positive		positive		fair positive		fair positive		positive		positive	
Distillation Test:												
Residue by Distillation, % by wt	65	-	65	-	65	-	65	-	60	-	60	-
Oil Distillate, % by volume of Emulsion	-	½	-	½	-	7	-	5	-	½	-	½
Tests on Residue from Distillation:												
Penetration at 77°F,100-g,5-sec	120	160	80	110	120	200	300	-	120	160	80	110
Solubility in Trichloroethylene, %	97.5	-	97.5	-	97.5	-	97.5	-	97.5	-	97.5	-
Ductility at 77° F, 5 cm/min, cm	100	-	80	-	100	-	-	-	100	-	80	-

Table 302.3.4.(d). Tests and Properties of Polymer Modified Emulsions

Property	High Float Anionic Rapid Setting		Cationic Rapid Setting	
	Type - Grade			
	HFRS-2P		CRS-2P	
	Min	Max	Min	Max
Polymer Content, percent by weight of the distillation residue [1]	3.0	-	3.0	-
Viscosity, Saybolt Furol at 122°F, sec	150	400	150	400
Storage Stability Test, 1-day, %	-	1	-	1
Demulsibility, 35-ml of 0.02 N $CaCl_2$, %	40	-	-	-
Demulsibility, 35-ml 0.8-percent sodium dioctyl sulfosuccinate, %	-	-	40	-
Sieve Test, %	-	0.10	-	0.10
Particle Charge Test	-		Positive	
Distillation Test:[2]				
Oil distillate, by volume of emulsion, %	-	½	-	½
Residue, % by wt	65	-	65	-
Tests on Residue from Distillation:				
Float Value at 140°F, sec	1200	-	-	-
Penetration, 77°F, 100-g, 5-sec	100	140	110	150
Ductility, 39.2°F, 5-cm/min, cm	50	-	50	-
Viscosity at 140°F, poises	1500	-	1300	-
Solubility in Trichloroethylene, %	97	-	97	-

1. The emulsion supplier shall furnish the CITY samples of the asphalt cement and polymer used in making the finished emulsion.
2. The temperature on the lower thermometer shall be brought slowly to 350°F plus or minus 10°F and maintained at this temperature for 20-minutes. The total distillation shall be completed in 60-minutes plus or minus 5-minutes from the first application of heat.

302.3.5. Emulsions for Priming, Curing and Erosion Control (PCE).

302.3.5.1. General Use Emulsions. The emulsion shall be a slow curing anionic or cationic emulsion of a petroleum based material in water. The supplier must state whether the material supplied is cationic or anionic. Such emulsions may be used for priming of base materials, curing seal for stabilized base materials, and erosion control applications such as dust control, soil surface stabilization, or mulch binder.

Emulsion properties shall fall within the ranges as shown in Table 302.3.5.1.(a) Tests and Properties of PCE (General Use) Emulsions. The base emulsion material may be diluted with water to achieve the desired concentration of residual with maximum dilution rates as indicated in Table 302.3.5.1.(b) Maximum Dilution Rate.

Table 302.3.5.1.(a) Tests and Properties of PCE (General Use) Emulsions

Property	Test Methods, Test Parameters	Minimum	Maximum
Viscosity	Saybolt Furol, 25°C	10-seconds	100-seconds
Sieve Test	Sieve Test	-	0.1 %
Miscibility	ASTM D244 Emulsified Asphalts, modified[1]	Passing	-
Residue by Evaporation	ASTM D244, modified[2]	60% by weight	-
Tests on Residue from Evaporation	Flash Point, C.O.C. Kinematic Viscosity, 60°C	200°C 100-cSt	- 350-cSt

1. Except the dilution shall use 350-ml of distilled or deionized water and a 100-ml beaker.
2. Except the sample shall remain in the oven until foaming ceases, then cooled and weighed.

Table 302.3.5.1.(b) Maximum Dilution Rate

Use	Maximum Dilution Rate
Priming of Base Materials	(1) part PCE to (3) parts water
Curing Seal	(1) part PCE to (3) parts water
Erosion Control	(1) part PCE to (7) parts water

302.3.5.2. Emulsions Specifically for Priming and Curing. Product shall be a water-based emulsion composed of petroleum of resin oil base with selective hardening and drying agents to form a road prime and sealer. Emulsions may be provided either concentrated or pre-diluted. Concentrated prime and/or road sealing emulsions specified in this Item 302.3.5.2. shall meet the requirements of Table 302.3.5.2.(a) Requirements for MCS-600-C – Concentrated. Diluted prime and/or road sealing emulsions specified in this Item 302.3.5.2. shall meet the requirements of Table 302.3.5.2.(b) Requirements for MCS-600-D – Dilute.

Table 302.3.5.2.(a) Requirements for MCS-600-C – Concentrated

Property	Test Methods, Required Test Parameters	Value	
		Minimum	Maximum
Appearance	Visual Inspection	Brown Liquid	
Viscosity S.F. at 77°F Sec	ASTM D244 Emulsified Asphalts	15	200
Residue, % min	ASTM D244, modified[1]	56	65
Miscibility Test	ASTM D244, modified[2]	No coagulation	
Moisture, wt %		-	48
Volatile %		35	-
% Non-Volatile Soluble in Trichloroethylene	AASHTO T 45-56	-	6
Accelerated Weathering (2-year exposure)	Federal Spec TT C-555 B, 40 ml	No material deterioration after exposure	
Resistance To wind and Driven Rain (@ 98 mph)	Federal Spec TT C-555 B, As 4ml sealer after cure	Passes/no wt. gain	
Ash, % wt.		-	8
Polymer, % wt.		-	4
Freeze Test (Concentrated Form)	3-cycle	Pass	
Particle Charge	ASTM D244	Positive	
Shaker Test 2- to 4-hrs.	Mix Burrell Wrist Action Shaker Model 75 set on Level 7, diluted 1 part water to 4 parts road prime, Sieve #40	-	1%

1. ASTM D244 Modified Evaporation Test for percent of residue is made by heating 50-gram sample to 300°F until foaming ceases, then cool immediately and calculate results.
2. Test procedure identical with ASTM D244, except that 0.02 Normal Calcium Chloride solution shall be used in place of distilled water.

Table 302.3.5.2.(b) Requirements for MCS-600-D – Dilute

Property	Test Methods, Test Parameters	Required Value	
		Minimum	Maximum
Appearance	Visual Inspection	Brown Liquid	
Viscosity S.F. at 77°F Sec	ASTM D244 Emulsified Asphalts	5	70
Residue, % min	ASTM D244, modified[1]	10	20
Miscibility Test	ASTM D244, modified[2]	No coagulation	
Moisture, wt %		-	90
Volatile %		90	-
% Non-Volatile Soluble in Trichloroethylene	AASHTO T 45-56	0	2
Accelerated Weathering (2-year exposure)	Federal Spec TT C-555 B, 40 ml	No material deterioration after exposure	
Resistance To wind and Driven Rain (@ 98 mph)	Federal Spec TT C-555 B, As 4ml sealer after cure	Passes/no wt. gain	
Ash, % wt.		-	2
Polymer, % wt.		-	1
Freeze Test (Concentrated Form)	3-cycle	Pass	
Particle Charge	ASTM D244	Positive	
Shaker Test 2- to 4-hrs. (non-diluted)	Mix Burrell Wrist Action Shaker Model 75 set on Level 7, Sieve #40	-	1%

1. ASTM D244 Modified Evaporation Test for percent of residue is made by heating 100-gram sample to 300°F until foaming ceases, then cool immediately and calculate results.
2. Test procedure identical with ASTM D244, except that 0.02 Normal Calcium Chloride solution shall be used in place of distilled water.

302.3.6. Specialty Emulsions. Specialty emulsions shall be slow setting emulsions of a petroleum-based material in water. Specialty emulsions may be used for purposes such as tack coat, fog seals, priming base materials, curing seal for stabilized base materials, recycled/reclaimed asphalt pavement (RAP) rejuvenator, repairing surface deficiencies, and erosion control applications. Specialty emulsions are classified as either Restorative Seal or Maltene Rejuvenator and shall meet the requirements for the specified type shown in Table 302.3.6.(a) Requirements for Restorative Seal or Table 302.3.6.(b) Requirement for Maltene Rejuvenator, respectively. Specialty emulsions shall be freeze stabilized and if freezing has occurred a homogeneous mixture shall be obtained when the material has thawed and been thoroughly mixed.

Table 302.3.6.(a) Requirements for Restorative Seal

Properties	Test Methods	Requirements
Test on Emulsion		
Viscosity @77°F (25°C), SES	ASTM D244 Emulsified Asphalts	25 - 150
Sieve Test, % by Wt.	ASTM D244, modified[1]	0.1 Max.
Particle Charge Test	ASTM D244	Positive
Cement Mixing Test, % by Wt.	ASTM D244	2.0 Max.
Pumping Stability	See Note 2.	Pass
5-day Settlement Test, % by Wt.	ASTM D244	5.0 Max.
Residue, % Wt.	ASTM D244, modified[3]	64 Min.
Test on Residue from Distillation		
Viscosity @ 140°F (60°C), cSt	ASTM D2170 Kinematic Viscosity of Asphalts (Bitumens)	1,000 – 4,000
Maltene Distribution Ratio[4]	ASTM D2006-70 Method of Test for Characteristic Groups in Rubber Extender and Processing Oils by the Precipitation Method (Discontinued 1975)	0.7 – 1.1
PC/S Ratio[4]	ASTM D2006-70	0.5 Min.
Asphaltenes, % Wt.	ASTM D2006-70	11.00 Max.

1. Test procedure identical with ASTM D244 except that distilled water shall be used in place of two-percent sodium oleate solution.
2. Pumping stability is determined by charging 15-ounces (450-ml) of emulsion into 30-ounce (one-liter) beaker and circulating the emulsion through a gear pump (Roper 29.B22621) having ¼" inlet and outlet. The emulsion passes if there is not significant oil separation after circulating ten-minutes.
3. ASTM D244 Evaporation Test for percent of residue is modified by heating 2-ounces (50-gram) sample to 300°F (149°C) until foaming ceases, then cooling immediately and calculating results.
4. In the Maltene Distribution Ratio Test by ASTM Method D2006-70:

   $(PC + A_1) \div (S + A_2)$

   PC=Polar Compounds A_1=First Acidaffins

   A_2= Second Acidaffins S= Saturated Hydrocarbons

Table 302.3.6.(b) Requirement for Maltene Rejuvenator

Properties	Test Methods		Requirements	
	ASTM	AASHTO	Min.	Max.
Test on Emulsion				
Viscosity @77°F (25°C), SES	D244 Emulsified Asphalts	T-59	15	40
Residue, % Wt.	D244 (Mod)[1]	T-59 (Mod)	60	65
Miscibility Test	D244 (Mod)[2]	T-59 (Mod)	No Coagulation	
Sieve Test, % by Wt.	D244 (Mod)[3]	T-59 (Mod)	-	0.1
Particle Charge Test	D244	T-59	Positive	
Percent Light Transmittance	See Note 4.		-	30
Test on Residue from Distillation				
Flash Point, COC, °F	D92 Flash and Fire Points by Cleveland Open Cup	T-48	385	-
Viscosity @ 140°F (60°C), cSt	D445 Kinematic Viscosity of Transparent and Opaque Liquids (the Calculation of Dynamic Viscosity)	-	100	200
Asphaltenes, % Wt.	D2006-70 Method of Test for Characteristic Groups in Rubber Extender and Processing Oils by the Precipitation Method (Discontinued 1975)	-	-	1.0
Maltene Distribution Ratio[5]	D2006-70		0.3	0.6
PC/S Ratio[5]	D2006-70	-	0.5	-
Saturated Hydrocarbons, [5]	D2006-70	-	21	28

1. ASTM D244 Modified Evaporation Test for percent of residue is made by heating 2-ounces (50-grams) sample to 300°F (149°C) until foaming ceases, then cool immediately and calculate results.
2. Test procedure identical with ASTM D244 except that 0.02 Normal Calcium Chloride solution shall be used in place of distilled water.
3. Test procedure identical with ASTM D244 except that distilled water shall be used in place of two-percent sodium oleate solution.
4. Test according to Attachment "Standard Procedure for Determining Percent Light Transmittance of Maltene Rejuvenator, Restorative Seal, and PCE Material" in TxDOT Special Provision to Item 300 for Maltene Rejuvenator (Waco District).
5. Chemical composition by ASTM Method D2006-70:
   $(PC + A_1) \div (S + A_2)$
   PC=Polar Compounds A_1=First Acidaffins
   A_2= Second Acidaffins S= Saturated Hydrocarbons

302.3.7. Emulsion for In-Place Asphalt Recycling. Emulsion shall be designed to be a recycling agent to be mixed at ambient temperature with existing in-place asphalt, native or selective material and or Recycled Asphalt Pavement (RAP) material. Product shall be a water miscible emulsion. Asphaltene, Resins, Cyclics, Saturates content must be specifically formulated based on laboratory data of existing material in relation to rejuvenation demand and any added RAP material. Product shall meet minimums and fall within the ranges specified in Table 302.3.7.(a) Emulsion Requirements for In-Place Asphalt Recycling.

Table 302.3.7.(a) Emulsion Requirements for In-Place Asphalt Recycling

Properties	Test Methods, Test Parameters	Requirements	
		Min.	Max.
Test on Emulsion			
Viscosity	Saybot Furol, 122°F	-	
Sieve %		-	
Particle Charge			Positive
Specific Gravity @ 77°F		0.910	1.16
Cement Mixing Test	ASTM D244	Passing	
Distillation			
Residue; % from Distillation @ 325°F		60	68
Test on Residue from Distillation			
Penetration, 77°F Extrapolation function		1400	-
Asphaltene, %		3.1	10.1
Resins, % wt.		1.2	8.9
Cyclics		65.0	95.0
Saturates		2.8	18.3
Flash Point C.O.C.		400°F	-

302.4. FIBROUS REINFORCEMENT FOR ASPHALT

302.4.1. General. At the CITY'S option, fibrous reinforcement may be used unless otherwise shown on the plans or in the contract documents. Fibrous reinforcement shall not be used as a replacement for any reinforcement required for structural purposes.

302.4.2. Material and Tests. Fibers for reinforcement of asphalt shall be cellulose tested by the methods and meeting the criteria in Table 302.4.2.(a) Cellulose Fiber Requirements.

Table 302.4.2.(a) Cellulose Fiber Requirements

Property	Test Methods	Requirements
Sieve Analysis		
Method A	Alpine Sieve Analysis[1]	
Fiber Length		0.25" (maximum)
Passing No. 100 sieve		70% (±10%)
Method B	Mesh Screen Analysis[2]	
Fiber Length		0.25" (maximum)
Passing No. 20 sieve		85% (± 10%)
Passing No. 40 sieve		65% (±10%)
Passing No. 140 sieve		30% (±10%)
Ash Content	See Note 3.	18% (± 5%) non-volatiles
pH	See Note 4.	7.5 (± 1.0%)
Oil Absorptions	See Note 5.	5.0 (± 1.0%) (times fiber weight)
Moisture Content	See Note 6.	< 5% (by weight)

1. Method A - Alpine Sieve Analysis. This test is performed using an Alpine Air Jet Sieve (Type 200 LS). A representative 5-gram sample of fiber is sieved for 14-minutes at a controlled vacuum of 11-psi. The portion remaining on the screen is weighed.
2. Method B - Mesh Screen Analysis. This test is performed using standard No. 20, 40, 60, 80, 100, 140 sieves, nylon brushes and a shaker. A representative 10-gram sample of fiber is sieved, using a shaker and 2 nylon brushes on each screen. The amount retained on each sieve is weighed and the percentage passing calculated. Repeatability of this method is suspect and needs to be verified.
3. Ash Content. A representative 2- to 3-gram sample of fiber is placed in a tared crucible and heated between 1100°F and 1200°F for not less than 2-hours. The crucible and ash are cooled in a desiccator and reweighed.
4. pH Test. 5-grams of fiber is added to 100-ml of distilled water, stirred and let sit for 30-minutes. The pH is determined with a probe calibrated with pH 7.0 buffer.
5. Oil Absorption Test. 5-grams of fiber is accurately weighed and suspended in an excess of mineral spirits for not less than 5-minutes to ensure total saturation. It is then placed in a screen mesh strainer (approximately 0.5-square-millimeter hole size) and shaken on a wrist action shaker for 10-minutes (approximately 1¼-inch motion at

240-shakes-per-minute). The shaken mass is then transferred without touching, to a tared container and weighed. Results are reported as the amount (number of times its own weight) the fibers are able to absorb.
6. Moisture Content. 10-grams of fiber is weighed and placed in a 250°F forced air oven for 2-hours. The sample is then reweighed immediately upon removal from the oven.

302.4.3. Rejection. Fibrous reinforcement for asphalt may be rejected for failure to meet any of the requirements of this specification.

302.5. STORAGE, HEATING AND APPLICATION TEMPERATURE OF BITUMINOUS MATERIALS

Asphalt materials should be applied at the temperature that provides proper and uniform distribution. Within practical limits, higher temperatures than necessary should be avoided. Satisfactory application should be obtained within the recommended ranges shown in Table 302.5.(a) Requirements for Storage, Heating and Application Temperature. No material shall be heated above the maximum temperature shown. Performance graded asphalt binders containing particulate or polymer modifiers may be susceptible to separation of the modifier. Appropriate circulation or agitation in storage shall be provided if separation of the modifier is expected or suspected, and in every case when the modified binder will be stored at elevated temperatures for more than one day before use.

WARNING TO CONTRACTOR: Attention is called to the fact that asphaltic materials are highly flammable. Heating of asphaltic materials constitutes a fire hazard to various degrees. The utmost care shall be taken to prevent open flames of any kind from coming in contact with the asphaltic material or the gases of same. Proper precautions should be used in all cases. The CONTRACTOR shall be responsible for any fires or accidents which may result from heating the asphaltic materials.

Binder or modifier supplier instructions regarding recommended application and storage temperatures shall supersede the guidelines below.

Table 302.5.(a) Requirements for Storage, Heating and Application Temperature

Material Type-Grade	Application and Mixing		Heating and Storage
	Recommended Range °F (°C)	Maximum Allowable °F (°C)	Maximum °F (°C)
All PG Binders	275-375 (135-191)	375 (191)	400 (204)
AC-3, 5, 10, 20	275-325 (135-163)	350 (177)	400 (204)
Emulsions			
SS-1, SS-1 h, SS-1 P, CSS-1 h	50-130 (10-54)	140 (60)	140 (60)
RS-2, RS-2h, MS-2, CRS2h, CRS-2P, CMS-2, CMS-2s, HFRS-2, HFRS-2P, AES-300	110-160 (43-71)	170 (77)	170 (77)
PCE, Restorative Seal or Maltene Rejuvenator	Ambient = 72-130 (22-54)	140 (60)	140 (60)

302.6. EMULSIFIED ASPHALT TREATMENT

302.6.1. Description. Emulsified asphalt treatment shall consist of one or more applications of a mixture of emulsified asphalt of the proportion and type specified on the plans and water. The mixture shall be applied at the rate specified on the plans. It is to be used as a base treatment, earthwork seal, prime coat or dust preventative. This mixture may be applied to the base course, subgrade, shoulders or detours at the locations and to the extent shown on plans or as directed by the CITY.

302.6.2. Materials. The amount of emulsified asphalt in the mixture, expressed as a percent by volume of the total mixture, shall be within the limits specified on the plans. When tested by approved laboratory methods, the emulsified asphalt used shall meet the requirements of Item 302.3.4. Emulsified Asphalt or Item 302.3.5. Emulsions for Priming, Curing, and Erosion Control (PCE) or Item 302.3.6. Specialty Emulsions.

The water used shall be clear, free from industrial wastes and other objectionable matter.

302.6.3 Construction Methods. Asphalt materials shall be handled in accordance with Item 302.5. Storage, Heating and Application Temperature of Bituminous Materials.

The emulsified asphalt and water mixture shall be applied by a self-propelled sprinkler meeting the requirements of Item 203.8. Dust Control so operated as to uniformly distribute the mixture in the quantity determined by the CITY.

The emulsion and water may be mixed in the sprinkler tank. The CONTRACTOR shall make suitable provisions for agitating the two materials sufficiently to produce a uniform blend. The sprinkler tank shall have been recently calibrated, and the CITY shall be furnished an accurate and satisfactory record of such calibration. After beginning the work, should the yield on the emulsion applied appear to be in error, the distributor shall be recalibrated in a manner satisfactory to the CITY, before proceeding with the work.

302.7. PRIME COAT

302.7.1. Description. This Item shall consist of application of asphaltic materials on the completed base course and/or other approved area, which shall be applied in accordance with these specifications and as shown of the plans.

302.7.2. Materials. The asphaltic material used for the prime coat shall be of the type and grade as stated in the contract and when tested by approved laboratory methods shall meet the requirements of Item 302.3.4. Emulsified Asphalt or Item 302.3.5. Emulsions for Priming, Curing, and Erosion Control (PCE) or Item 302.3.6. Specialty Emulsions.

302.7.3. Equipment. All storage tanks, piping, retorts, booster tanks and distributors used in storing and handling asphaltic material shall be kept clean and in good condition at all times. Equipment shall be operated in such a manner that there shall be no contamination of the asphaltic material with foreign material. It shall be the responsibility of the CONTRACTOR to provide and maintain in good working order a recording thermometer at the storage heating unit at all times. The distributor shall have been recently calibrated and the CITY shall be furnished an accurate and satisfactory record of such calibration. After beginning the work, should the yield on the asphaltic material applied appear to be in error, the distributor shall be recalibrated in a manner satisfactory to the CITY before proceeding with the work.

302.7.4. Construction Methods. Asphalt materials shall be handled in accordance with Item 302.5. Storage, Heating and Application Temperature of Bituminous Materials.

Prime coat shall not be applied when the air temperature is below 50°F (10°C) and falling, but it may be applied when the air temperature is above 40°F (5°C) and rising, the air temperature being taken in the shade and away from artificial heat. Asphaltic material shall not be placed when general weather conditions, in the opinion of the CITY, are not suitable.

When, in the opinion of the CITY , the base is thoroughly dry and is satisfactory to receive the prime coat, the surface shall be cleaned by sweeping or other approved methods. The asphaltic material shall be applied to the cleaned base at the approximate rate of 0.15- to 0.25-gallons-per-square-yard (0.75- to 1.25-L-per-m_2) of surface area. The application shall be made with an approved type of self-propelled pressure distributor so constructed and operated as to distribute the material evenly and smoothly in the quantity specified or directed. The CONTRACTOR shall provide all necessary facilities for determining the temperature of the asphaltic material in all of the heating equipment and in the distribution, for determining the rate at which it is applied, and for securing uniformity at the junction of two distributor loads.

The CITY shall select the temperature of application within the limits recommended in Item 302.5. Storage, Heating and Application Temperature of Bituminous Materials based on the temperature-viscosity relationship that shall permit application of the asphalt. The CONTRACTOR shall apply the asphalt at a temperature within 15°F (3°C) of the temperature selected.

No traffic, hauling or placing of subsequent courses shall be permitted over the freshly applied prime coat until authorized by the CITY.

The CONTRACTOR shall be responsible for the maintenance of the surface until the work is accepted by the CITY.

302.8. ASPHALT BASE COURSE

302.8.1. Description. Asphalt base course shall consist of a compact mixture of mineral aggregates and asphaltic material mixed hot in a mixing plant. It may be a base course, subbase course, or foundation course. It is made of larger aggregate than Hot-Mix Coarse Base (A) as shown in Table 302.9.3.(a) Dense Graded Hot Mix Master Grading.

302.8.2. Materials.

302.8.2.1. Asphaltic Cement. Asphalt for the mixture shall be of the types of asphalt cement as determined by the CITY and shall meet the requirements of Item 302.3.2. Performance-Graded (PG) Asphalt Binders or Item 302.3.3. Asphalt Cement. The grade of asphalt to be used shall be determined by the CITY after design tests have been made using the mineral aggregate approved for use in the construction. If more than one type of asphaltic cement mixture is specified for the project, only one grade of asphalt shall be required for all types of mixture unless otherwise shown on the plans. The CONTRACTOR shall notify the CITY of the source of asphaltic material prior to production of the asphaltic mixture, and this source shall not be changed during the course of the project, except by written permission of the CITY.

302.8.2.2. Tack Coat. The liquid asphalt material used for tack coat should be MS-2 or SS-1 in Item 302.3.4. Emulsified Asphalt, Restorative Seal in Item 302.3.6. Specialty Emulsions or one of the other various grades of materials (selected by the CITY) listed under Item 302.3.4. Emulsified Asphalt.

302.8.2.3. Mineral Aggregate. The material shall be crushed and screened as necessary to meet the requirements hereinafter specified and shall consist of durable coarse aggregate particles mixed with approved binding materials.

Unless otherwise specified, the grading of the mineral aggregate shall conform to the limitations as shown in Table 302.8.2.3.(a). Asphalt Base Course Aggregate Grades.

Table 302.8.2.3.(a). Asphalt Base Course Aggregate Grades

Sieve Size	Grade			
	1	2	3	4
1 3/4-inch		100.0	100.0	As Shown on Plans
1 1/2-inch	100.0	90.0-100.0		
1-inch	90.0-100.0			
3/8-in.	45.0-70.0			
No. 4	30.0-55.0	25.0-55.0		
N o. 40	15.0-30.0	15.0-40.0	15. 0-40. 0	

Testing of the mineral aggregate shall be in accordance with the test methods in Table 302.8.2.3.(b) Aggregate Tests.

Table 302.8.2.3.(b) Aggregate Tests

Property	Test
Preparation of Soil Constants	Tex-101-E Preparing Soil and Flexible Base Materials for Testing
Liquid Limit	ASTM D4318 Liquid Limit, Plastic Limit, and Plasticity Index of Soils
Plastic Limit	ASTM D4318 (same as above)
Plasticity Index	ASTM D4318 (same as above)
Sieve Analysis	ASTM C136 Sieve Analysis of Fine and Coarse Aggregates
Wet Ball Mill	Tex-116-E Ball Mill Method for Determining the Disintegration of Flexible Base Material
Sand Equivalent	ASTM D2419 Sand Equivalent Value of Soils and Fine Aggregate

Unless otherwise specified on the plans, the mineral aggregate for Grades 1, 2 and 3 shall meet the limits of Table 302.8.2.3.(c) Aggregate Physical Requirements. Mineral aggregate for Grade 4 shall meet the physical requirements shown on the plans.

Table 302.8.2.3.(c) Aggregate Physical Requirements

Property	Limit
Wet Ball Mill	50 Max.
Plasticity Index	15 Max.
Liquid Limit	40 Max.
Sand equivalent	~ 40

302.8.3. Construction Methods. Asphalt materials shall be handled in accordance with Item 302.5. Storage, Heating and Application Temperature of Bituminous Materials.

Mixing plants may be either the weight-batching type plant, the continuous mixing type plant, or the drum mixing type plant as described in Item 302.9.5. Mixing Plants except that requirements for Type “B” and “D” mixtures of fine graded surface course are deleted.

Equipment for storage, weighing and heating of materials shall be as described in Item 302.9.4. Equipment.

The CITY shall designate the asphalt content to be used in the mixture after design tests have been made with the aggregates to be used in the project. When tests as determined by the CITY are made, samples of the mixture shall not vary from the asphalt content designated by the CITY by more than 0.5-percent dry weight (based on total mixture). The asphaltic material will form typically 4- to 9-percent of the mixture by weight.

The mixture shall consist of a uniform mixture of mineral aggregates and asphaltic material.

The asphaltic mixtures for the weight-batching type plant and from the continuous mixing type plant, when tested in accordance with the current methods outlined in TxDOT Test Method Tex-208-F Test for Stabilometer Value of Bituminous Mixtures (Part I or Part III as applicable), shall have laboratory density and stability as indicated in Table 302.8.3.(a) Stability of Asphalt Base Course. If the mixture produced does not have the specified qualities, the mixture shall be changed until it conforms to the specified qualities.

Table 302.8.3.(a) Stability of Asphalt Base Course

Property	Value
Density (%)	96 ±2
Stability (%) Hveem Stabilometer	Not less than 40 except when otherwise shown on the plans

302.9. HOT-MIX ASPHALT PAVEMENT

302.9.1. Description. This Item shall govern pavement consisting of a binder course, a leveling up course, a surface course or any combination of these courses as shown on the plans. Each course shall be composed of a compacted mixture of mineral aggregate and asphaltic material mixed hot in a mixing plant; and shall be constructed on the previously completed and approved subgrade, subbase course, base course, existing pavement, or in the case of a bridge, on the prepared floor slab, all in accordance with these specifications and in conformity with the lines, grades, quantities and typical sections as stated in the contract, plans and/or established in the field by the CITY.

302.9.2. Materials. The materials proposed to be used may be inspected and tested at any time during the preparation of the work.

302.9.2.1. Aggregates. Mineral aggregates shall consist of a fine aggregate, coarse aggregate and, when required, a mineral filler all in accordance with Item 302.2. Aggregates for Hot-Mix Asphalt Pavement and approved by the CITY. Representative samples of the materials proposed to be used in the mixture shall be submitted for tests in the quantities required by the CITY. No material that has in any way become unfit for use after approval shal be used in the work. Approval of both the materials and sources of supply must be obtained from the CITY prior to delivery of the material.

302.9.2.2. Asphaltic Materials. Material shall conform to the applicable paragraphs of Item 302.3. Bituminous Materials. Only one grade of asphalt shall be required for all the types of mixtures unless otherwise shown on the plans or required by the CITY.

302.9.2.2.1. Paving Mixture. Asphaltic materials for the paving mixture shall be the type and grade specified, shown on the plans, or as designated by the CITY after design tests have been made, using the mineral aggregates proposed to be used in the mixture, and shall meet the requirements of Item 302.3.2. Performance Graded (PG) Asphalt Binders or Item 302.3.3. Asphalt Cement. If more than one type of asphaltic pavement mixture is specified for the project, only one grade of asphalt shall be required for all types of mixtures, unless otherwise shown on the plans. The CONTRACTOR shall notify the CITY of the source of asphaltic material prior to production of the asphaltic mixture and prior to the paving of this course of the project except on written permission of the CITY.

302.9.2.2.2. Prime Coat. Prime coat shall conform to the provisions of Item 302.7. Prime Coat.

302.9.2.2.3. Tack Coat. The liquid asphalt material used for tack coat should be MS-2 or SS-1 in Item 302.3.4. Emulsified Asphalt, Restorative Seal in Item 302.3.6. Specialty Emulsions or one of the other various grades of materials (selected by the CITY) listed under Item 302.3.4. Emulsified Asphalt.

302.9.2.3. Cellulose Fiber. Cellulose fiber may be used in the mixture to prevent excessive draindown. The cellulose fiber shall be of the type shown on the plans and shall meet the requirements of Item 302.4. Fibrous Reinforcement for Asphalt.

302.9.3. Paving Mixture. The paving mixture shall consist of a uniform mixture of coarse aggregate, fine aggregate, mineral filler, when required, and asphaltic material, accurately proportioned by weight. The grading of each constituent shall be such as to produce, when properly proportioned, a mixture conforming to the following limitations for grading the type specified. The exact proportions of each constituent producing the total aggregate within these limits shall be as directed by the CITY, and when tested by standard laboratory methods, the mixture shall meet the requirements listed in Tables 302.9.3.(a) through (f). The CITY shall specify or approve a mixture within the specified limits for all types of mixtures, which shall be suitable for the work in which the asphaltic pavement shall be used. The percentages of asphalt shall not vary more than 0.4-percent from the proportions established by the CITY.

Table 302.9.3.(a) Dense Graded Hot Mix[1] Master Grading

Sieve Size	Type of						
	A Coarse Base	B Fine Base	C Coarse Surface	D Fine Surface	F Fine Mixture	CMHB – C Coarse Surface	CMHB – F Fine Surface
	Percent Passing by Weight						
1 ½"	100						
1¼"	95-100						
1 "		100					
~"	70-90	95-100	100			98 –100	
~"		75-95	95-100			95 –100	
½"	50-70			100			98 –100
~"		60-80	70-85	85-100	100	50-70	85 - 100
¼"					95-100		
No. 4	30-50	40-60	43-63	50-70		30 - 45	40 - 60
No. 10	20-34	27-40	30-40	32-42	32-42	15 - 25	15 - 25
No. 40	5-20	10-25	10-25	11-26	9-24	6 – 20	6 – 20
No. 80	2-12	3-13	3-13	4-14	3-13	6 – 18	6 – 18
No. 200	2 - 8	2 - 8	2 - 8	2 - 8	2 - 8	5 - 8	5 - 8
VMA % minimum	11	12	13	14	15	14	15

1. These mixtures shall be designed using a Texas Gyratory Compactor (TGC) and in accordance with Test Method Tex-204-F Design of Bituminous Mixtures. Design must be researched and based on intended use.

Table 302.9.3.(b) Superpave Hot Mix[1] Master Grading

Sieve Size, inches (centimeters)	Nominal Maximum Aggregate Size, Inches (centimeters)				
	1½ (3.81)	1 (2.54)	¾ (1.90)	½ (1.27)	(0.95)
	Coarse Base	Fine Base	Coarse Surface	Fine Surface	Fine Mixture
	Percent Passing By Weight				
2 (5.08)	100.0				
1 ½ (3.81)	90.0 – 100.0	100.0			
1 (2.54)		90.0 – 100.0	100.0		
¾ (1.90)			90.0 – 100.0	100.0	
½ (1.27)				90.0 – 100.0	100.0
3/8 (0.95)					90.0 –
No. 4					
No. 8	15.0 - 41.0	19.0 – 45.0	23.0 - 49.0	28.0 – 58.0	32.0 – 67.0
No. 16					
No. 30					
No. 50					
No. 100					
No. 200	0.0–6.0	1.0 – 7.0	2.8 - 8.0	2.0 - 10.0	2.0 – 10.0
VMA % minimum	11	12	13	14	15

1. These mixtures shall be designed using a Superpave Gyratory Compactor (SGC) and in accordance with the AASHTO Standard Practice for Designing Superpave Hot Mix Asphalt (PP28-99). Design must be researched and based on intended use.

Table 302.9.3.(c) Superpave – Plant Produced Mixture Requirements

VMA (MIN)	VFA	Dust/Asphalt Ratio
11.0%	64 – 77 %	0.6 – 1.8 %
12.0%	67 – 77 %	0.6 – 1.6 %
13.0%	69 – 80 %	0.6 – 1.6 %
14.0%	71 – 80 %	0.6 – 1.6 %
15.0%	73 – 80 %	0.6 – 1.6 %

Table 302.9.3.(d) Cellulose Modified Mixtures[1] Master Grading

Sieve Size	Stone Mastic Asphalt (SMA)		Permeable Friction Course (PFC)	
	¾"	½"	½"	½" Modified
	Coarse Surface	Fine Surface	Coarse Surface	Fine Surface
	Percent Passing By Weight			
¾"	100.0			
½"	99.0-100.0	100.0	90.0-100.0	85.0-100.0
~"	70.0-85.0	70.0-90.0	35.0-60.0	55.0-75.0
No. 4	30.0-42.0	30.0-50.0	10.0-25.0	15.0-25.0
No. 8	20.0-33.0	20.0-30.0	5.0-10.0	5.0-10.0
No. 16		21.0 max		
No. 30		18.0 max		
No. 50		15.0 max		
No. 100				
No. 200	8.0-11.0	8.0-12.0	1.0 - 4.0	2.0 - 4.0

1. These mixtures shall be designed using a Superpave Gyratory Compactor (SGC) and in accordance with the AASHTO Standard Practice for Designing Superpave Hot Mix Asphalt (PP28-99). Design must be researched and based on intended use.

Table 302.9.3.(e) Cellulose Modified Mixture Properties

Property	Requirements	
	Stone Mastic Asphalt (SMA)	Permeable Friction Course (PFC)
Air Voids, %	4.0 (Lab Molded)	20.0 Min. (Lab Molded)
Cellulose Fibers, %	0.4	0.4
VMA, Percent (Min.)	17.0 (Plant); 17.5 (Design)	
VCA_1 (Mix), Percent	Less Than VCA (DRC)	
TSR, Percent	80.0 Min. (Tex-531-C)	
Draindown @ Production Temp., %	0.30 Max. (T305)	0.30 Max. (T305)
Asphalt Content, Percent	6.0 Min.	6.0 Min.
N(Des)	100	20

1. See NCHRP Report 425 for definition and calculation of VCA (Voids in Coarse Aggregate).

302.9.3.1. Extraction Test. When required by the CITY, samples of the asphaltic mixture may be taken from the plant, trucks or finished pavement for check tests. The minimum weight of the test specimen in grams shall be 3000 times the maximum size of aggregate in inches, and when tested in accordance with Recovery of Asphalt from Solution by Abson Method and Quantitative Extraction of Bitumen from Bituminous Paving Mixtures, ASTM Designations D1856 and D2172, respectively, it shall not vary from the grading proportions specified for the mixture being used by more than 5-percent.

302.9.3.2. Stability. The asphaltic mixture from the weight-batching plant and from the continuous mixing type plant, when tested in accordance with the current methods outlined in the TxDOT Test Method Tex-208-F Test for Stabilometer Value of Bituminous Mixtures, shall have the laboratory density and stability indicated in Table 302.9.3.(f) Asphalt Pavement Mixture Stability. If the mixture produced does not have the specified qualities, the mixture shall be changed until it conforms to the specified qualities.

Table 302.9.3.(f) Asphalt Pavement Mixture Stability

Property	Value
Density (%)	96 ±1
Stability (%) Hveem Stabilometer	Unless otherwise shown on the plans, Not less than 40 applied on arterials with truck traffic, and Not less than 35 for residential applications

302.9.4. Equipment. All equipment necessary for the construction of the hot-mix asphalt pavement shall be on the project and shall be approved by the CITY as to condition before the CONTRACTOR shall be permitted to begin construction operations on which the equipment is to be used. All equipment shall be maintained in good repair and operating condition.

302.9.4.1. Bins. Bin storage shall be provided with tight cut-off gates to prevent leakage of aggregates or mineral filler into the weight box. The weight box for aggregates shall be of sufficient capacity to hold a complete batch of aggregates and mineral filler without wasting or leveling and shall be so designed that it shall quickly discharge the entire batch into the mixer. The weight box shall be provided with a close fitting and quick operating cut-off gate so that there shall be no leakage of the aggregates into the mixer and shall be satisfactorily attached to the batching scales.

302.9.4.2. Scales. Scales used for weighing different grades of mineral aggregates may be either the springless dial type or the multi-beam type. All scales must be a tare beam for balancing. The beam scales must also be equipped with a telltale indicator of the springless dial type indicating over-and-under loads of at least 50-pounds (23-kg). Scales shall be accurate within 4-pounds-per-1000-pounds (2-kg-per-454-kg). If plant vibration interferes with accurate weighing, the scales shall be insulated against shock or vibration.

302.9.4.3. Material Bucket. The asphaltic material bucket shall be of sufficient size to hold the necessary asphaltic material for one batch. If the material is measured by weight, the bucket shall be properly attached to the scales herein specified. If the proportioning is by volume based on weight, the measuring bucket used shall be of the overflow type and shall meet the requirements of the CITY.

302.9.4.4. Asphalt Storage. Asphalt storage shall be sufficient to meet the requirements of the plant. Asphalt in storage shall be heated by steam coils, absolutely tight to prevent leakage of moisture into the asphalt; the steam for heating shall not be at a temperature in excess of 400°F (204°C); direct fire heating of the asphalt shall not be permitted. Agitating asphalt with steam or air shall not be permitted.

302.9.4.5. Steam Heating Systems. The steam heating system shall insure the maintaining of the asphalt at a uniform draw-off temperature at the asphalt bucket of between 275°F and 375°F (135°C - 190°C). The temperature shall be maintained with an efficient positive control of heat at all times as directed or approved by the CITY. Asphalt heated beyond 375°F (190°C) either before or during mixing with the mineral aggregate shall be rejected. The draw-off at the asphalt bucket shall be of a quick cut-off type which shall not leak. The asphalt supply line shall be of circulating type, and equipped with a recording thermometer indicating the temperature of the asphalt at the draw-off valve. This thermometer may be combined with the one used in recording the temperature of the aggregate.

302.9.4.6. Weight Bucket. The asphalt weight bucket shall be of an approved type. The scales of weighing the asphalt shall be either the springless dial type or the multi-beam type. The dial type shall be arranged for rapid adjustment at zero and shall be provided with a pointer to indicate the weight of the asphalt required in one batch. The beam type shall have a tare beam for balancing and shall be equipped with a telltale indicator of the springless dial type. If plant vibration interferes with accurate weighing, the scales shall be insulated against shock or vibration. The asphalt shall be sprayed into the mixer through an approved spray bar that shall distribute the asphalt uniformly throughout the length of the mixer.

302.9.4.7. Mixer. The mixer shall be of the pugmill type and shall have a capacity of not less than 1,000-pounds (450-kg) in a single batch. The number of blades and their positions shall give a uniform and complete circulation of the batch. A mixer that segregates mineral aggregate or fails to secure a thorough and uniform mixing with the asphalt and mineral filler shall not be permitted to be used. The adequacy of the mixer to produce a successful mix shall be determined by mixing the standard batch for the required time, then dumping the batch, and taking samples from different parts of the batch; the samples shall be tested by the extraction test and shall show that the batch is uniform throughout.

All mixers shall be provided with an automatic time lock on the discharge gates of the mixer and the weigh box; and shall be locked for a period of 45-seconds after all the mineral aggregates have been introduced into the mixer. When discharged, the mixture shall have a temperature of 225°F to 350°F (107°C - 177°C). The dump doors of the mixer shall be tight to the dry mineral aggregate or dust so that there shall be no spilling from the pugmill or drum. In introducing the batch into the mixer, all mineral aggregates shall first be introduced. Aggregates shall be thoroughly mixed for a period of 5- to 10-seconds before the asphalt is added; then the total mixture shall be mixed for the time required to produce a homogeneous mixture, in which all particles of the aggregates are uniformly coated.

302.9.4.8. Spreading and Finishing Machine. The spreading and finishing machine shall be of a type approved by the CITY and capable of producing a surface that shall meet the requirements of the typical cross section and surface test.

302.9.4.9. Rollers. Rollers shall meet the governing specifications for Item 301.1.2. Rolling of Embankment, Subgrade or Flexible Base.

302.9.4.10. Straightedges. The CONTRACTOR shall provide acceptable 16-ft. (5m) straightedges for the surface testing. Satisfactory templates shall be provided as required by the CITY.

302.9.4.11. Vehicles for Transporting Mixture. Asphaltic concrete shall be transported from the plant to the site of the work in tight vehicles with metal bottoms previously cleaned of all foregoing substances. The CITY may require that the vehicles be suitably insulated, and each load shall be covered with canvas or other suitable material of sufficient size to protect the asphaltic concrete from the weather and to prevent loss of material.

302.9.5. Mixing Plants. Mixing plants may be either the weight-batching plant, the continuous mixing type plant or the drum mixing type plant as hereinafter described. All types of plants shall be equipped with satisfactory conveyors, power units, aggregates handling equipment, hot-aggregates screens and bins and dust collectors.

Temporary storing or holding of the asphaltic mixture by a surge-storage system is permitted during the normal day's operation. Overnight storage shall not be permitted.

302.9.5.1. Weight Batching Plant. The proportioning of the various materials entering into the asphaltic mixture shall be as approved or directed by the CITY. The CITY shall have access at all times to all parts of the paving plant. The plant shall be of the batch type provided with separate storage bins and chambers for heating and mixing the materials.

The various sizes of mineral aggregates as received shall be stored or stockpiled separately, and the feeding of all sizes of mineral aggregates to the dryer shall be done by mechanical means that shall give a uniform and continuous feed to each of the sizes incorporated in order to give a control of the temperature and grading of the mineral aggregates.

The drying of the mineral aggregates shall be done in such a manner that the finer particles shall not escape with the furnace gases. If forced draft is used, a dust collector system shall be installed. If natural draft is used, the CITY may require a dust collector system to prevent loss of the finer particles. The aggregate shall be heated in a suitable apparatus that continuously agitates the aggregate during the heating and in which the temperature can be efficiently and positively controlled so that the aggregates shall not be damaged and the mixture produced shall have a temperature between 225°F and 350°F (107°C and 177°C).

A recording thermometer shall be provided which shall record the temperature of the aggregates as they leave the dryer. The recording thermometer shall be provided with a 24-hour chart and may be so equipped that it shall record both the temperature of the aggregates and the temperature of the asphalt incorporated into the batch. The drying apparatus shall be of sufficient size to dry and heat the amount of aggregates required to maintain the plant in continuous operation.

The screening capacity and size of the bins shall be sufficient to screen and store the amount of aggregates required to properly operate the plant and keep the plant in continuous operation at full capacity. Provisions shall be made to enable inspection forces to have easy and safe access to the proper location on the mixing plant where representative samples may be taken from the hot bins for testing. The aggregates shall be separated into at least four bins when producing Type “B” mixtures and at least three bins when producing Type “D” mixtures. If mineral filler is needed, an additional bin shall be provided. These bins shall contain the sizes of aggregates as shown in Table 302.9.3.(a) Dense Graded Hot Mix Master Grading.

302.9.5.2. Continuous Mixing Plant. Cold-aggregates bin and proportioning devices, dryer, and screening and proportioning shall conform to the requirements hereinabove for the weight-batching type of plant. The hot-aggregates proportioning device shall be so designed that when properly operated, a uniform and continuous flow of aggregates into the mixer shall be maintained.

An accurate asphaltic material meter shall be installed in the asphalt line leading to the spray bar, so that the amount of asphalt being used can be accurately determined. The asphaltic material spray bar shall be so designed that the asphalt shall be uniformly and continuously sprayed into the mixture.

The mixer shall be of the pugmill continuous type and shall have a capacity of not less than 40-tons-perhour (1,450-metric-tons-per-hour) of mixture. Any mixer that segregates the aggregates or fails to secure a through and uniform mixing of the aggregates or fails to secure a thorough and uniform mixing of the aggregates with the asphaltic material shall not be used. This shall be determined by taking samples from different parts of a truckload and testing by the extraction test. These tests must show that the load is uniform throughout.

The amount of aggregates and asphaltic material entering the mixer and the rate of travel through the mixer shall be so coordinated that a uniform mixture of the specified grading and asphalt content shall be produced. The mixture shall not vary from the specified mixture by more than the specified tolerances.

The asphaltic mixture shall be at a temperature of between 225°F and 350°F (107°C and 177°C) when dumped from the mixer. The CITY shall determine the lowest temperature, within the above limitations, at which the material can be satisfactorily dried, mixed, transported, spread and compacted, and the mixture furnished by the CONTRACTOR shall be between this determined temperature and 30°F (17°C) higher.

302.9.5.3. Drum Mixing Plant. The plant shall be adequately designed and constructed for the process of mixing aggregates and asphalt in the drum mixer. The plant shall be equipped with satisfactory conveyors, power units, aggregates-handling equipment and feed controls and shall consist of the following essential pieces of equipment.

The number of compartments in the cold-aggregates bin shall be equal to or greater than the number of stockpiles of individual materials to be used. The bin shall be of sufficient size to store the amount of aggregates required to keep the plant in continuous operation and of proper design to prevent overflow of material from one compartment to another. The feed system shall provide a uniform and continuous flow of aggregates in the desired proportion to the drum mixer.

A surge-storage system shall be required. It shall be adequate to minimize the production interruptions during the normal day's operations and shall be constructed to minimize segregation. A device such as gob hopper or other similar device approved by the CITY to prevent segregation in the surge-storage bin shall be required.

The system shall provide positive weight measurement of the combined cold-aggregates feed by use of belt scales or other approved devices. Provisions of a permanent nature shall be made for checking the accuracy of the measuring device as required by Item 302.9.4. Equipment. When a belt scale is used, mixture production shall be maintained so that the scale normally operates between 50-percent and 100-percent of its rated capacity. Belt scale operation below 50-percent of the rated capacity may be allowed by the CITY if accuracy checks show the scale to meet the requirements of Item 302.9.4. Equipment at the selected rate, and it can be satisfactorily demonstrated to the CITY that the mixture uniformity and quality have not been adversely affected.

An asphaltic material measuring device meeting the requirements of Item 302.9.4. Equipment shall be placed in the asphalt line leading to the drum mixer so that the cumulative amount of asphalt used can be accurately determined. Provisions of a permanent nature shall be made for checking the accuracy of measuring device output. The asphalt measuring device and line to the measuring device shall be protected with a jacket of hot oil or other approved means to maintain the temperature of the line and measuring device near the temperature specified for the asphaltic material. Unless otherwise shown on the plans, the temperature of the asphaltic material entering the measuring device shall be maintained at ±10°F (±5.5°C) of the temperature at which the asphalt measuring device was calibrated and set.

The asphaltic material feed-control shall be coupled with the total aggregate weight measuring device in such manner as to automatically vary the asphalt-feed rate as required to maintain the required proportion. A scalping screen shall be required, unless otherwise shown on the plans, and shall be located ahead of any weighing device.

The asphaltic mixture shall be at a temperature of between 225°F and 350°F (107°C and 177°C) when dumped from the mixer. The CITY shall determine the lowest temperature, within the above limitations, at which the material can be satisfactorily dried, mixed, transported, spread and compacted, and the mixture furnished by the CONTRACTOR shall be between this lowest determined temperature and 30°F (17°C) higher. The drum mix system shall be of the type that continually agitates the aggregates and asphalt mixture during heating and in which the temperature can be so controlled that aggregates and asphalt shall not be damaged in the necessary drying and heating operations required to obtain a mixture of the specified temperature. A continuously recording thermometer shall be provided which shall indicate the temperature of the mixture as it leaves the drum mixer.

Scales may be standard platform truck scales, belt scales or other equipment such as weigh hopper (suspended) scales approved by the CITY. All scales shall conform to Item 302.9.4. Equipment. If truck scales are used, they shall be placed at a location approved by the CITY. If other weighing equipment is used, the CITY may require weight checks by truck scales for the basis of approval of the equipment.

302.9.5.4. Special Instructions for Cellulose Fiber. A separate dry storage area or silo shall be required for cellulose fiber. All equipment used in the storage and handling of cellulose fibers shall be kept a clean condition at all times and shall be operated in such a manner that there will be no contamination with foreign matter.

Cellulose fibers shall be added at 0.3% ±0.1 % by mass of the mixture. Drainage shall be tested according to Tex-235-F Determination of Draindown Characteristics in Bituminous Materials. Draindown shall not exceed 0.3%-per-hour.

The cellulose fiber feed system shall supply the proper amount of cellulose fiber to the weigh box. Feeding of the cellulose fiber shall be performed in a manner such that the fibers are not damaged during the feeding and mixing processes and in a manner such that a uniform and constant flow of materials in the required proportions is maintained. The cellulose fiber storage capacity shall be ample to meet the requirements of the plant. Cellulose fiber shall not be allowed in the hot bins.

Mixing system shall control temperature so that the cellulose fiber will not be damaged in drying, heating and mixing operations.

302.9.5.4.1. Weight Batching Plant. Cellulose fiber shall be introduced into the pugmill during the dry mixing of the aggregates, prior to injection of the asphalt.

In introducing the batch into the mixer, all aggregates and then all cellulose fiber shall be introduced first and shall be mixed thoroughly for a minimum period of 5-seconds to uniformly distribute the various sizes of the aggregate and cellulose fiber throughout the batch before asphaltic material is added. The asphaltic material shall then be added and the mixing continued for a wet mixing period of not less than 15-seconds. The mixing period shall be increased if, in the opinion of the Engineer, the mixture is not uniform or the aggregates are not properly coated.

302.9.5.4.2. Continuous Mixing Plant. The mixing requirements shall be the same as is required for a standard Weigh-Batch Plant.

302.9.5.4.3. Drum-Mix Plant. Cellulose fiber shall be added to the mixture during the dry mixing process, unless otherwise approved by the Engineer. Cellulose fiber shall be uniformly dispersed in the mixture. Engineer may require that fiber be introduced into the drum dryer at the recycle port by use of a vane feeder.

The amount of aggregate, cellulose fiber and asphaltic material entering the mixer and the rate of travel through the mixing unit shall be so coordinated that a uniform mixture of the specified grading, cellulose fiber content and asphalt content is produced.

302.9.6. Construction Methods. Asphalt materials shall be handled in accordance with Item 302.5. Storage, Heating and Application Temperature of Bituminous Materials.

The prime coat, tack coat or the asphaltic mixture shall not be placed when the air temperature is below 50°F (10°C) and is falling but may be placed when the air temperature is above 40°F (5°C) and is rising, the temperature being taken in the shade and away from artificial heat; with the provision that the asphaltic mixture shall be placed only when the humidity, general weather conditions and temperature and moisture condition of the base, in the opinion of the CITY, are suitable.

302.9.6.1. Prime Coat. If required, a prime coat shall be applied to the completed subgrade, subbase or base, in accordance with Item 302.7. Prime Coat. The type and grade of asphaltic material and the application rate shall be as shown on the plans or as directed by the CITY.

302.9.6.2. Tack Coat. A tack coat shall be applied when the surface to be paved is Portland cement concrete, brick or asphaltic pavement. When a tack coat is required, it shall consist of an application of the asphaltic material indicated and shall be at the rate specified on the plans or as directed by the CITY, but not to exceed $1/_{10}$ (0.10) gallons-per-square-yard (0.5-L-per-m_2) of surface area. The surfaces of curbs, gutters, vertical faces of existing pavements and all structures in actual contact with asphaltic mixes shall be painted with a thin, complete coating of asphaltic material to provide a closely bonded, watertight joint.

302.9.6.3. Compacted Thickness of Hot-Mix Asphalt Pavement Surface Courses and Base Courses.

302.9.6.3.1. Base Courses. The compacted thickness or depth of each base course shall be as shown on the plans. Where the plans require a depth or thickness of the course greater than 4-in. (10cm), same shall be accomplished by constructing multiple lifts of approximately equal depth, each of which shall not exceed 4-in. (10cm) compacted depth. If, in the opinion of the CITY, an additional tack coat is considered necessary between any of the multiple lifts, it shall be applied as in Item 302.9.6.2. Tack Coat and at the rate as directed.

302.9.6.3.2. Surface Courses. The compacted thickness or depth of the asphalt pavement surface course shall be as shown on the plans. Where the plans require a depth or thickness of the surface course greater than 2-in. (5cm) compacted depth, same shall be placed in multiple courses of equal depth, each of which shall not exceed 2-in. (5cm) compacted depth. If, in the opinion of the CITY, an additional tack coat is considered necessary between any of the multiple courses, it shall be applied as in Item 302.9.6.2. Tack Coat and at the rate as directed.

302.9.6.4. Transporting Hot-Mix Asphalt Pavement Material. The mixture shall be hauled to the job site in tight vehicles previously cleaned of all foreign material. The dispatching of vehicles shall be arranged so that all material delivered shall be placed and all rolling shall be completed during daylight hours. In cool weather, or for long hauls, canvas covers may be required. The inside of the truck body may be given a light coating of an approved release agent, if necessary, to prevent the mixture from adhering to the body.

302.9.6.5. Temperature. The hot-mix asphalt mixture shall be at a temperature between 275° and 350°F (135° to 177°C) when dumped from the mixer. The CITY shall determine the temperature, within the above limitations. The mixture when dumped from the mixer shall not vary from this selected temperature more than 30°F (17°C). Restrictions on maximum mixture temperatures placed by environmental regulatory agencies supersede the maximum temperature listed above.

302.9.6.6. Placing. The hot-mix asphalt mixture shall be placed on the approved base course with the specified spreading and finishing machine in such manner that, when properly compacted, the finished course shall comply with the maximum thickness requirements, be smooth and of uniform density, and meet the requirements of the typical cross sections and the surface test. During the placing and spreading of the hot-mix asphalt material, care shall be taken to prevent the spilling of the material onto adjacent pavement, gutters or structures.

In small areas, which are inaccessible to the spreading and finishing machine, hand spreading may be authorized by the CITY, provided an acceptable surface can be obtained.

302.9.6.7. Compaction. Rolling with the 3-wheel and tandem roller shall start longitudinally at the sides and proceed toward the center of the surface course, overlapping on successive trips by at least half the width of the rear wheels. Alternate trips of the roller shall be slightly different in length. Rolling with the pneumatic tire roller shall be done as directed by the CITY. Rolling shall continue until no further compression can be obtained and all roller marks are eliminated. The motion of the rollers shall be slow enough at all times to avoid displacement of the asphaltic surface material. If displacement should occur, it shall be corrected at once by the use of rakes and fresh asphaltic mixtures where required. The roller shall not be allowed to stand on the surface course when it has not been fully compacted and allowed to cool. To prevent adhesion of the surface course to the roller, the wheels shall be kept thoroughly moistened with water, but an excess of water shall not be permitted. All rollers must be in good mechanical condition. All necessary precautions shall be taken to prevent the dripping of gasoline, oil, grease or other foreign matter on the surface course while the rollers are in motion or when standing. In areas where the surf ace course cannot be compacted with the rollers, hand tamps, lightly oiled, shall be used to secure the required compaction.

With approval by the CITY, the vibratory steel wheel roller may be substituted for the 3-wheel roller and tandem roller. Each course, after final compaction, shall have a relative density of not less than 92-percent. The relative density will be determined using Tex-207-F Determining Density of Compacted Bituminous Mixtures and Tex-227-F Theoretical Maximum Specific Gravity of Bituminous Mixtures.

302.9.6.8. Surface Tests. The finished surface of the pavement after compression shall be smooth and true to the established line, grade and cross section. When tested with a 16-ft. (5m) straightedge placed parallel to the centerline of the roadway, the finished surface shall have no deviation in excess of $_1/_{16}$-in-per-foot (5-mmper-m) from the nearest point of contact. The maximum ordinate measured from the face of the straightedge shall not exceed ¼-in. (6mm) at any point. Any point in the pavement surface not meeting these requirements shall be immediately corrected.

302.9.6.9. Pavement Thickness Test. Upon completion of the work and before final acceptance and final payment shall be made, pavement thickness test shall be made by the CITY or its authorized representative unless otherwise specified in the special provisions or in the plans. The number and location of tests shall be at the discretion of the CITY. The cost for the initial pavement thickness test shall be at the expense of the CITY. In the event a deficiency in thickness of pavement is revealed during normal testing operations, subsequent tests necessary to isolate the deficiency shall be at the CONTRACTOR'S expense. The cost for the additional coring test shall be at the same rate charged by commercial laboratories.

ITEM 303. PORTLAND CEMENT CONCRETE PAVEMENT

303.1. DESCRIPTION

This item shall consist of finished pavement constructed of Portland cement concrete on the prepared subgrade or other base course, in conformity with the plans, as herein specified and as supplemented and/or amended by special provisions and to the lines and grades as established by the CITY. Concrete shall be considered of satisfactory quality, provided it is:

(1) Made of materials acceptable to the job and meeting the requirements of Item 303.2. Portland Cement Concrete Materials and special provisions and amendments thereto;
(2) In the proportions approved by the CITY; and
(3) Mixed, placed, finished and cured in accordance with the requirements of these specifications and any special provisions.

303.2. PORTLAND CEMENT CONCRETE PAVEMENT MATERIALS

303.2.1. Aggregates for Portland Cement Concrete Pavement.

303.2.1.1. General Requirements. Aggregates for Portland cement concrete shall conform to the requirements contained in this Item and shall be approved by the CITY prior to use. Aggregates shall be of such character that it shall be possible to produce workable concrete within the limits contained in this specification.

303.2.1.1.1. Storage. The manner of handling and storage of aggregates shall be such as to prevent intrusion of foreign materials and segregation of sizes. If materials are stored on the ground, the stockpile sites shall be grubbed, cleaned of all vegetation and leveled. In this case, the bottom six-in. layer of aggregate shall not be disturbed and shall not be used in the work.

Where two or more sizes or types of aggregates are delivered to the job, each size or type shall be stored separately.

Aggregates shall be stockpiled on the job or at a central batching plant for a minimum of 24-hours prior to use in the project. At the plant, the aggregate shall be wetted to a uniform moisture content of not less than three-percent below saturated surface dry condition before or while being loaded for shipment. Care shall be exercised to maintain this uniformity of moisture until the aggregates are used in the mix. Wetting of stockpiles to maintain the required percent moisture shall be performed at least 12-hours prior to use.

At the time of use, the aggregates shall be free from frozen material and foreign matter. All grass, wood, sticks, burlap, paper or other material which may have become mixed with the aggregates while stockpiled or in handling must be removed.

303.2.1.1.2. Aggregate Measuring. The fine and coarse aggregates shall be measured loose and separately.

By Weight. Aggregate weighing equipment shall conform to the requirements of ASTM C94 Standard Specification for Ready-Mixed Concrete and shall be approved by the CITY prior to use.

By Volume. The volume measuring equipment shall consist of approved boxes, pans or mechanical devices, which, while in operation, shall give the required volumes of the different kinds of aggregates required for the several classes of concrete. Equipment shall also be so marked and designed that the CITY can accurately and conveniently check the quantities of each aggregate being used.

Concrete made by continuous mixing shall conform to ASTM C685 Concrete Made by Volumetric Batching and Continuous Mixing.

303.2.1.1.3. Tests. Test of aggregates shall be made in accordance with the applicable current ASTM standards, listed in Table 303.2.1.1.3.(a) Aggregate Tests.

Table 303.2.1.1.3.(a) Aggregate Tests

ASTM Designation	Standard Specification or Standard Test Method (Title)
C29	Bulk Density ("Unit Weight") and Voids in Aggregate
C33	Concrete Aggregates
C40	Organic Impurities in Fine Aggregates for Concrete
C88	Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
C123	Lightweight Particles in Aggregate
C125	Terminology Relating to Concrete and Concrete Aggregates
C127	Density, Relative Density (Specific Gravity) and Absorption of Coarse Aggregate
C128	Density, Relative Density (Specific Gravity) and Absorption of Fine Aggregate
C131	Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
C136	Sieve Analysis of Fine and Coarse Aggregates
C142	Clay Lumps and Friable Particles in Aggregates
C330	Lightweight Aggregates for Structural Concrete
C535	Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
C641	Staining Materials in Lightweight Concrete Aggregates
D8	Terminology Relating to Materials for Roads and Pavements
D75	Sampling Aggregates
D422	Particle-Size Analysis of Soils
D4318	Liquid Limit, Plastic Limit, and Plasticity Index of Soils
D2217	Wet Preparation of Soil Samples for Particle-Size Analysis and Determination of Soil Constants

303.2.1.2. Fine Aggregates. Fine aggregate shall consist of natural sand, manufactured sand or a combination of the two, with or without mineral filler. The sand, or mixture of sand, comprising a single fineaggregate, shall consist of clean, hard, durable, uncoated grains and shall be essentially free from clay lumps.

303.2.1.2.1. Foreign Material and Deleterious Substances. The maximum permissible percentage, by weight, of deleterious substances shall not exceed the amounts in Table 303.2.1.2.1.(a) Deleterious Substances in Fine Aggregates.

The fine aggregate shall be free from an excess amount of salt or alkali and at the time of use shall be free from frozen and/or all foreign material.

Table 303.2.1.2.1.(a) Deleterious Substances in Fine Aggregates

Substance	Maximum % by Weight
Material removed by decantation	3.0%[1]
Other deleterious substances such as coal, shale, coated grains and soft flaky particles	3.0%

1. An additional loss of two-percent by decantation may be allowed, provided this new additional loss is material of the same quality as specified for fine aggregate or mineral filler.

303.2.1.2.2. Gradation. The fine aggregate shall be well graded from fine to coarse and when tested by standard laboratory sieves shall meet the requirements of Table 303.2.1.2.2.(a) Grading Requirements for Fine Aggregates.

Table 303.2.1.2.2.(a) Grading Requirements for Fine Aggregates

Sieve	Percent Passing by Weight
~-in. sieve (9.5mm)	100%
No. 4 sieve (4.75mm)	95 to 100%
No. 8 sieve (2.36mm)	80 to 100%
No. 16 sieve (1.18mm)	50 to 85%
No. 30 sieve (600um)	25 to 65%
No. 50 sieve (300um)	10 to 30%
No. 100 sieve (150um)	0 to 10%
No. 200 sieve (75um)	0 to 3%

303.2.1.2.3. Mineral Filler. Stone dust or crushed sand may be added as a mineral filler, if so directed by the CITY. Amounts of mineral filler shall not exceed 5-percent of the fine aggregate to improve the workability or quality specified for fine or coarse aggregates. When tested by standard laboratory sieves shall meet the requirements of Table 303.2.1.2.3.(a) Fine Aggregate Mineral Filler.

Table 303.2.1.2.3.(a) Fine Aggregate Mineral Filler

Sieve	Percent Passing
No. 30 sieve (600um)	95 to 100%
No. 100 sieve (150 um)	70 to 100%

303.2.1.2.4. Rejection. Fine aggregates which fail to meet the requirements of these specifications may be rejected by the CITY. Such rejection shall incur no cost to the CITY.

Fine aggregates sources, from which materials with properties not meeting these specifications are delivered, may be rejected as further supply sources to the project by the CITY. Such rejection shall incur no cost to the CITY.

303.2.1.3. Coarse Aggregates. Coarse aggregates shall consist of durable particles of crushed gravel, crushed stone, crushed blast furnace slag meeting the requirements of ASTM C989 (Standard Specification for Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars) Grade 100 or 120, recycled crushed Portland cement concrete, or a combination of these.

303.2.1.3.1. Foreign Material and Deleterious Substances. The maximum permissible percentage, by weight, of deleterious substances shall not exceed the amounts in Table 303.2.1.3.1.(a) Deleterious Substances in Coarse Aggregates.

Aggregates shall be free from injurious amounts of salt, alkali, vegetable matter, or other objectionable material either free or as an adherent coating. At the time of their use, aggregates shall be free from frozen and/or all foreign material that may have become mixed with them in the stockpile.

Table 303.2.1.3.1.(a) Deleterious Substances in Coarse Aggregates

Substance	Maximum % by Weight
Material removed by decantation	1.0%
Shale, slate or other similar material	1.0%
Clay lumps	0.25%
Soft fragments	3.0%
Other deleterious substances, including friable, thin, elongated or laminated pieces	3.0%
The sum of all deleterious substances, exclusive of material removed by decantation	5.0%

303.2.1.3.2. Gradation. Coarse aggregates shall be well graded in size from coarse to fine. When tested by standard laboratory methods, coarse aggregates shall meet the requirements in Table 303.2.1.3.2.(a) Grading Requirements for Coarse Aggregates for percentage passing each sieve by weight.

Coarse aggregates of different characteristics, though tested and approved, shall not be mixed with other aggregates; but shall be stored, batched and weighed separately.

The difference in percent passing between two adjacent sieve sizes shall not exceed 20%.

Maximum Size Aggregate. The maximum size aggregate is defined as the clear space between the sides of the smallest square openings through which 95-percent of the weight of the aggregate can be passed. The maximum size of aggregates for paving concrete shall not exceed 1½-inches, and shall be reduced in size to meet the following conditions:

(1) one-fifth of the least dimension between forms of that part of the structure in which concrete is to be placed;
(2) three-fourths of the clear space between reinforcement; and
(3) one-third the depth of the slab.

Table 303.2.1.3.2.(a) Grading Requirements for Coarse Aggregates

Size No.	Nominal Size (Sieve with Square Openings)	Amounts Finer than Each Laboratory Sieve (Square-Opening), Mass Percent													
		100 mm (4 in)	90 mm (3½ in.)	75 mm (3 in.)	63 mm (2½ in.)	50 mm (2 in.)	37.5 mm (1½ in.)	25.0 mm (1 in.)	19.0 mm (¾ in.)	12.5 mm (½ in.)	9.5 mm (¼ in)	4.75 mm (No. 4)	2.36 mm (No. 8)	1.18 mm (No. 16)	0.30 mm (No. 50)
1	90 t0 37.5 mm (3½ to 1½ in.)	100	90 to 100	_	25 to 60	_	0 to 15	-	0 to 5	-	-	-	-	-	-
2	63 to 37.5 mm (2½ to 1½ in.)	-	-	100	90 to 100	35 to 70	0 to 15	-	0 to 5	-	-	-	-	-	-
3	50 to 25.0 mm (2 to 1 in.)	-	-	-	100	90 to 100	35 to 70	0 to 15	-	0 to 5	-	-	-	-	-
357	50 to 4.75 mm (2 in to No. 4)	-	-	-	100	95 to 100	-	35 to 70	-	10 to 30	--	0 to 5	-	-	-
4	37.5 to 19.00 mm (1½ to ¾ in.)	-	-	-	-	100	90 to 100	20 to 55	0 to 15	-	0 to 5	-	-	-	-
467	37.5 to 4.75 mm (1½ in to No. 4)	-	-	-	-	100	95 to 100	-	35 to 70	-	10 to 30	0 to 5	-	-	-
5	25.0 to 12.5 mm (1 to ½ mm)	-	-	-	-	-	100	90 to 100	20 to 55	0 to 10	0 to 5	-	-	-	-
56	25.0 to 9.5 mm (1 to ~ in.)	-	-	-	-	-	100	90 to 100	40 to 85	10 to 40	0 to 15	0 to 5	-	-	-
57	25.0 to 4.75 (1 to No. 4)	-	-	-	-	-	100	95 to 100	-	25 to 50	-	1 to 10	0 to 5	-	-
6	19.0 to 9.5 mm (¾ to ~ in.)		-	-	-	-	-	100	90 to 100	20 to 55	0 to 15	0 to 5	-	-	-
67	19.0 to 4.75 mm (¾ in to No. 4)	-	-	-	-	-	-	100	90 to 100	-	20 to 55	0 to 10	0 to 5	-	-
7	12.5 to 4.75mm (½ in to No. 4)	-	-	-	-	-	-	-	100	90 to 100	40 to 70	0 to 15	0 to 5	-	-
8	9.5 to 2.36 mm (~ in to No. 8)	-	-	-	-	-	-	-	-	100	85 to 100	10 to 30	0 to 10	0 to 5	_
89	9.5 to 1.18 mm (~ in to No. 16)	-	-	-	-	-	-	-	-	100	90 to 100	20 to 55	5 to 30	0 to 10	0 to 5
9[1]	4.75 to 1.18 mm (No. 4 to No. 16)	-	-	-	-	-	-	-	-	-	100	85 to 100	10 to 40	0 to 10	0 to 5

1. Although size 9 aggregate is defined in ASTM C125 Standard Terminology Relating to Concrete and Concrete Aggregates as a fine aggregate, it is included as a course aggregate when it is combined with a size 8 material to create a size 89, which is a course aggregate as defined by ASTM C125.

303.2.1.3.3. Tests. Results of tests performed according to the applicable standard test methods listed in Table 303.2.1.1.3.(a) Aggregate Tests shall meet the criteria specified by the CITY. Coarse Aggregates shall have a percent wear of not more than 45 when tested by abrasion and impact in the Los Angeles machine, ASTM C131 and C535.

303.2.1.3.4. Rejection. Coarse aggregates which fail to meet the requirements of these specifications may be rejected by the CITY. Such rejection shall incur no cost to the CITY.

Coarse aggregate sources, from which materials with properties not meeting these specifications are delivered, may be rejected as further supply sources to the project by the CITY. Such rejection shall incur no cost to the CITY.

303.2.2. Portland Cement. Cement shall be either Type I, II, III or Type IP (ASTM C595 Blended Hydraulic Cements), of a standard brand of Portland cement which shall conform to the requirements of ASTM C150 Portland Cement, or other applicable test methods of the ASTM.

303.2.2.1. Delivery. Cement delivered in bags shall be legibly marked on the bag with brand and name of the manufacturer, shall be in good condition at the time of delivery, and shall contain 94-pounds (43kg) net. Bags of cement varying more than 5-percent from the specified weight may be rejected, and if the average net weight in any shipment, as determined by weighing 50 bags taken at random, is less than 94-pounds (43kg), the entire shipment may be rejected. Cement salvaged from discarded or used bags shall not be used.

Cement delivered in bulk may be used, provided the manner and method of handling is approved by the CITY. When delivered in bulk, the brand name of the manufacturer contained in the shipping information

accompanying the shipment shall be furnished to the CITY prior to the use of the cement. Bulk cement shall be weighed on approved scales.

Cement from different manufacturers, although tested and approved, shall not be mixed, except as approved by the CITY.

The CONTRACTOR, when required, shall furnish to the CITY, with each shipment of cement, a statement as the specific surface of the cement expressed in square-centimeters-per-gram.

303.2.2.2. Cement Weighing Equipment. Bulk cement shall be batched by weight. The scales shall be either the beam or springless dial type, of substantial construction with a maximum allowable error of 0.5-percent of the net load and with minimum gradations of not greater than 5-pounds (2.5kg). Provisions shall be made for indicating to the operator that the required load in the weight box or container is being approached, which device shall indicate at least the last 50-pounds (23kg) of the load. Dial type scales shall be provided with a pointer to the dial.

When a closed-type cement box is used, the cement-weighing scales shall be provided with a springless dial indicator or tare beam to indicate when the weigh box is empty. This indicator for the empty condition of the weigh box shall be in continuous operation. The weigh box shall be fitted with an approved vent and a tightly covered inspection opening of not less than 12-sq.in. (77-cm_2). The weigh box and scales shall be maintained in a satisfactory condition to meet the requirements for accuracy for weight.

303.2.2.3. Volume and Weight of Bag of Cement. A bag of cement as packed by the manufacturer and weighing 94-pounds (43kg) shall be considered 1-cubic-foot (0.28m_3).

303.2.2.4. Storage. Cement shall be stored in a suitable weathertight building which shall protect the cement from dampness, and placed in such manner that shall permit easy access for proper inspection and identification of each shipment.

303.2.2.5. Rejection. Cement may be rejected for failure to meet any of the requirements of this specification and shall be rejected under the following specific conditions:

(1) any bag of cement which has partially set or which contains any lumps or cakes;
(2) all cement salvaged from torn, discarded or used bags; or
(3) bulk cement which has partially set or which contains any lumps or cakes.

303.2.3. Chemical Admixtures. Unless otherwise provided in the plans or special provisions, approved types of chemical 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 CITY and in accordance with the manufacturer's recommendations.

Admixtures shall be dispensed in a form by an accurate mechanical dispenser designed for convenient confirmation of the accuracy of measurement. Dispensers shall have sufficient capacity to measure at one time the full quantity required for each batch. Two or more admixtures of different types, such as a water-reducing and air-entraining admixture, may not be compatible when mixed together. Where different admixtures are used, they should be added to the batch separately unless it is known that they can be mixed together satisfactorily. Dosage of admixtures shall not vary from the dosage order by the CITY by more than 5-percent. In addition:

(1) Chemical admixtures shall conform to ASTM C494 Chemical Admixtures for Concrete, Types "A", "D," "F" and "G" for concrete dosages in accordance with manufacturer's recommendations as specified by the CITY.

Water-reducing admixtures conforming to ASTM C494, Types "A" and "F", shall be used to improve quality of concrete by obtaining specified strength at lower cement content and to increase slump without increasing water-cement ratio and may also be utilized in improving properties of concrete containing aggregates that are harsh or poorly graded.

Water-reducing, set retarding admixtures, conforming to ASTM C494, Type "D" and "G", may be used during hot weather concrete placement, so as to keep concrete workable during the entire placing period, in order that succeeding placements may be made without development of cold joints or discontinuities in the structural unit.

(2) CITY'S option: High range water-reducing admixtures, super-plasticizers conforming to ASTM C494, Type "F" and "G", may be used to greatly reduce water content to obtain dense concrete with higher early strengths and maintain high slump or flowing concrete while maintaining low water-cement ratio for concrete that must be placed under difficult conditions such as pump or tremie methods, etc.

(3) Air-entraining admixtures shall conform to ASTM C260 Air-Entraining Admixtures for Concrete. Dosage shall conform to recommendations of manufacturer, as specified by CITY, and determined by field testing of concrete mixture by qualified testing personnel in accordance with ASTM C94 Ready-Mixed Concrete. The CONTRACTOR shall secure the approval of the CITY for the particular admixture which it proposes to incorporate into the concrete prior to actual use of the admixture. The CONTRACTOR shall furnish such information

and evidence that the CITY may require in its determination of the acceptability of the proposed admixture. When the CONTRACTOR proposes to use an air-entraining admixture which has been previously approved by the CITY, it shall submit a certification stating that the admixture is the same as that previously approved.

Either prior to or at any time during construction, the CITY may require that the air-entraining admixture selected by the CONTRACTOR be tested to determine its effect upon the strength of the concrete. When so tested, a 7-day compressive strength of concrete, made with cement and aggregates in proportions to be used in the work and containing the admixture in an amount sufficient to produce from 3- to 6-percent entrained air in the plastic concrete, shall be no less than 85-percent of the strength of concrete, made with the same materials and with the same cement content and consistency but without the admixture.

Any other admixtures for whatever purpose shall have the approval of the CITY prior to incorporation into the concrete mix.

303.2.4. Mineral Admixtures. Fly ash shall conform to the requirements of ASTM C618 Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete, with the exception that the “Loss on Ignition” requirements shall be a maximum of 3-percent. Fly ash shall be sampled and tested at a frequency schedule in accordance with the requirements of ASTM C311 Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use as a Mineral Admixture in Portland-Cement Concrete. All sources of fly ash for use in Portland cement concrete shall conform to the requirements of Texas Department of Transportation (TxDOT) Material Specification DMS-8900 Fly Ash.

With the approval of the CITY, fly ash may be used in all classes of concrete to replace a portion of the Portland cement in a mix design. Unless otherwise approved by the CITY, the maximum cement reduction shall not exceed 25-percent by weight per cubic-yard of concrete. If historical data and general practice in locality of usage substantiates fly ash concrete using higher percentages, CONTRACTOR may submit written request to CITY for review. Fly ash replacement shall be on a weight basis. The minimum replacement ratio shall be 1.0-pounds of fly ash per 1.0-pounds (1 kg-per-1 kg) of cement replaced.

The water-cement ratio of the concrete mix shall be based on total cementitious (cement plus fly ash) materials. Proposed concrete mix designs with materials certification data and laboratory or field mix test results on the properties of the fresh or hardened concrete shall be submitted to the CITY for approval.

303.2.5. Mineral Filler. Mineral filler shall consist of stone dust, crushed sand or other inert material approved by the CITY. Mineral filler may be added in amounts not to exceed 10-percent of the weight of the sand or mixture of sands to improve the workability or plasticity of the concrete mix. Such mineral filler shall be of the quality specified for fine or coarse aggregate, and when tested by laboratory methods shall meet the requirements of Table 303.2.5(a) Mineral Filler.

Where mineral filler is used, it shall be measured by volume or weighed and batched separately.

Table 303.2.5.(a) Mineral Filler

Sieve	Percent Retained on Sieve
No. 30 sieve (600um)	0%
No. 200 (75 um)	0% to 35%

303.2.6. Fibrous Reinforcement. At the CITY’S option, fibrous reinforcement in concrete may be used unless otherwise shown on the plans or in the contract documents. Fibrous reinforcement shall not be used as a replacement for any reinforcement required for structural purposes.

303.2.6.1. Material. Fibers for reinforcement of concrete shall be in accordance with materials specified in ASTM C1116 Fiber-Reinforced Concrete and Shotcrete.

303.2.6.2. Length and Size. The fibers shall be length and size as specified in ASTM C1116.

303.2.6.3. Testing. Test methods ASTM C995 Time of Flow of Fiber-Reinforced Concrete Through Inverted Slump Cone, and ASTM C1018 Flexural Toughness and First-Crack Strength of Fiber-Reinforced Concrete (Using Beam With Third-Point Loading) in addition to applicable ASTM methods for the testing of concrete shall be used to test the fiber-reinforced concrete. Performance of fiber-reinforced concrete shall meet all requirements as specified in Section 21 of ASTM C1116.

303.2.6.4. Rejection. Fibrous reinforcement or fiber-reinforced concrete may be rejected for failure to meet any of the requirements of this specification or ASTM C1116.

303.2.7. Water. Water for use in concrete shall be reasonably clean and free of oil, acid, alkali, organic matter or other deleterious substances. Water which is suitable for drinking or ordinary household uses may be accepted for use without being tested.

303.2.7.1. Source. Water shall be obtained preferably from a domestic water supply. Where other source of supply is proposed, the approval of the CITY must be obtained prior to using the water.

303.2.7.2. Measuring Devices. The device for measuring the quantity of water shall indicate the quantity in gallons or pounds and fractions thereof. The operating mechanism shall regulate the quantity required for any given batch within one(1)-percent. The supply inlet shall be cut off automatically when the water is discharged into the mixer.

Upon approval of the CITY, the water for any one batch in the mixer may be measured in approved cans, buckets or other containers, and no more than the required amount of water shall be introduced into the mixer. The measuring devices shall be checked at the beginning of each job.

303.2.7.3. Tests. If the water is of questionable quality, it shall be tested in accordance with the standard Method of Test of Quality of Water to be used in concrete, AASHTO T26.

303.2.7.4. Rejection. Water for use with cement may be rejected for failure to meet any of the requirements of this specification.

303.2.8. Dowel Bars. Dowel and tie bars shall be either straight or bent, smooth or deformed, as shown on the plans and shall conform to the requirements of Item 303.2.9. Steel Reinforcement. The dowel bars shall be coated with either hot asphalt or an alternate coating, as designated on the plans, to the extent shown on the plans.

303.2.8.1. Dowel Caps. Caps for slip dowel bars shall be of the length shown on the plans and shall have an internal diameter sufficient to permit the cap to freely slip over the bar. In no case shall the internal diameter exceed the bar diameter by more than ~-in. (0.3cm), and one end of the cap shall be rightly closed. The cap shall be installed to allow the bar to move not less than 1¼-in. (3cm) in either direction.

303.2.9. Steel Reinforcement. Concrete reinforcement is the metal (rods or fabric) imbedded in concrete in such a manner that the reinforcement and concrete act together in resisting forces.

303.2.9.1. Material. Unless otherwise specified or designated on the plans, the metal for all bar reinforcement shall be one of the following:

303.2.9.1.1. New billet steel. New billet steel shall meet the requirements of ASTM A615/A615M Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.

303.2.9.1.2. Axle steel. Axle steel shall meet the requirements of ASTM A996/A996M Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement.

303.2.9.1.3. Rail steel. Axle steel shall meet the requirements of ASTM A996/A996M Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement.

The use of rail steel or axle steel shall not be permitted where bending of the bar is required.

Unless otherwise designated on the plans, all reinforcement steel bars shall be deformed in accordance with the requirements of ASTM A615/A615M or A996/A996M, as appropriate. Twisted bars are not considered deformed and shall not be used. The deformed bars shall provide a net sectional area at all points equivalent to that of plain square or round bars of equal nominal size.

Bars for spiral reinforcement shall be plain bars rolled from billets directly reduced from ingots and shall conform to the requirements of ASTM A615/A615M.

303.2.9.2. Sizes and Weights. The size and weight of reinforcing bars shall conform to the requirements of ASTM A615/A615M.

303.2.9.3. Bending. Reinforcement bars shall be bent cold to the shapes indicated on the plans. All bending of hard grade new billet steel shall be done in the shop. Bends shall be true to the shapes indicated, and irregularities shall be cause for rejection. Unless otherwise shown on the plans, bends for stirrups and ties shall be made around a pin having a diameter not less than two times the minimum thickness of the bar. Other bends shall be made according to the latest code of Standard Practice of the Reinforcing Steel Institute.

303.2.9.4. Storage. Reinforcement shall be stored above the ground surface upon skids, platforms or other supports, and shall be protected from mechanical injury and surface deterioration caused by exposure to the conditions producing rust. When placed in the work, the reinforcement shall be free from dirt, loose rust, scale, painting, oil or other foreign material.

303.2.9.5. Rejection. Reinforcement may be rejected for failure to meet any of the requirements of this specification, and specifically for the following:

(4) reinforcement exceeding the allowable variations,
(5) reinforcement not bent in accordance with the details,
(6) reinforcement with a coating of dirt, loose scale, paint, oil or other foreign substances which shall prevent bonding of the concrete and reinforcement, or
(7) twisted bars.

303.2.10. Steel Wire Reinforcement. At the CITY'S option the use of welded wire fabric may be used in lieu of deformed reinforcement bars unless otherwise shown on the plans or in the contract specifications.

Welded wire fabric shall be delivered to the job site in sheets. Rolls of wire fabric shall not be permitted.

The size of welded wire fabric shall be 12 x 12- W 4 x W 4 with a nominal diameter in inches of 0.225 and a nominal weight 0.136 lbs/linear foot.

303.2.10.1. Material. Wire for fabric reinforcement shall be cold-drawn from rods hot-rolled from billets and shall conform to the requirements of ASTM A82 Steel Wire, Plain, for Concrete Reinforcement. Welded wire fabric shall conform to the requirements of ASTM A185 Steel Welded Wire Reinforcement, Plain, for Concrete.

303.2.10.2. Sizes and Weights. The properties of wire fabric shall conform to the requirements of ASTM A82 or ASTM A185, as appropriate.

303.2.10.3. Storage. Reinforcement shall be stored above the ground surface upon skids, platforms or other supports, and shall be protected from mechanical injury and surface deterioration caused by exposure to the conditions producing rust. When placed in the work, the reinforcement shall be free from dirt, loose rust, scale, paint, oil or other foreign materials.

303.2.10.4. Rejection. Reinforcement may be rejected for failure to meet any of the requirements of this specification, and specifically for the following:

(1) reinforcement exceeding the allowable variations,
(2) reinforcement not bent in accordance with the details,
(3) reinforcement with a coating of dirt, loose scale, paint, oil or other foreign substances which shall prevent bonding of the concrete and reinforcement, or
(4) twisted bars.

303.2.11. Reinforcement Bar Chairs. Reinforcement bar chairs or supports shall be of adequate strength (if specified) to support the reinforcement bars and shall not bend or break under the weight of the reinforcement bars or CONTRACTOR'S personnel walking on the reinforcing bars.

Bar chairs may be made of metal (free of rust), precast mortar or concrete blocks or plastic. Pre-cast mortar or concrete blocks must be approved by the CITY; and the CONTRACTOR shall supply test data showing the strength of the mortar or concrete blocks.

For approval of plastic chairs, representative samples of the plastic shall show no visible indications of deterioration after immersion in a 5-percent solution of sodium hydroxide for 120-hours.

303.2.11.1. Rejection. Bar chairs may be rejected for failure to meet any of the requirements of this specification.

303.2.12. Joint Filler. Joint filler is the material placed in concrete pavement and concrete structures to allow for the expansion and contraction of the concrete.

303.2.12.1. Material. Expansion joint materials shall consist of boards or a premolded asphalt board tested in accordance with ASTM D545 Test Methods for Preformed Expansion Joint Fillers for Concrete Construction (Nonextruding and Resilient Types).

Boards for expansion joint filler shall be of the required size, shape and type indicated on the plans or required in the specifications. Boards shall be of selected stock of redwood, cypress, gum, southern yellow pine, or Douglas fir timber. The boards shall be sound heartwood and shall be free from sapwood, knots, clustered birdseyes, checks and splits. Occasional sound or hollow birdseyes, when not in clusters, shall be permitted, provided the board is free from any other effects that shall impair its usefulness as a joint filler. With the exception of redwood and cypress, all boards shall be preservative treated according to American Wood-Preservers' Association (AW PA) Standards.

Asphalt boards for expansion joint filler shall be of the required size and uniform thickness and, when used in transverse joints, they shall conform approximately to the shape of the pavement crown shown on the plans and details. Asphalt boards shall consist of two liners of 0.016 asphalt impregnated kraft paper filled with a mastic mixture of asphalt and vegetable fiber and/or mineral filler. Boards shall be smooth, flat and straight throughout, and shall be sufficiently rigid to permit ease of installation. Boards shall be furnished in lengths equal to the width between longitudinal joints, and may be furnished in strips or scored sheet of the required shape.

Asphalt boards, when tested in accordance with the following described methods, shall not deflect from the horizontal more than ¾-inches in 3½-inches (2cm in 9cm). A sample of the board, 2-in. (5cm) wide and 6-in. (15cm) long, flat, straight and cut with its length parallel to the lay of the fiber, shall be clamped between two blocks in the direction of its thickness in such manner that 3½-in. (9cm) length of the sample shall extend unsupported and at right angles from the common plane of the block faces. The samples and clamp so assembled shall be maintained at a temperature of 180°F (82°C) for 2-hours, with the length and width of the clamped portion of the sample horizontal after which the deflection from the horizontal of the unclamped portion shall be immediately measured.

303.2.12.2. Dimensions. The thickness of the expansion joint filler shall be shown on the plans; the width shall be not less than that shown on the plans, providing for the top seal space.

303.2.12.3. Rejection. Expansion joint filler may be rejected for failure to meet any of the requirements of this specification.

303.2.13. Curing Materials. This specification shall govern the materials to be used in the curing of concrete. The materials when applied as elsewhere specified shall retain the moisture, present in the concrete at the time of application of curing material, within specified limits for the curing period.

303.2.13.1. Material. Materials for the curing of concrete shall conform to the following requirements:

303.2.13.1.1. Membrane-Forming Compounds. The membrane curing compound shall conform to the requirements of ASTM C309 Liquid Membrane-Forming Compounds for Curing Concrete, Type 2, white pigmented compound, unless otherwise specified or indicated. It shall be of such nature that it shall not produce permanent discoloration of concrete surfaces nor react deleteriously with the concrete.

The compound shall produce a firm, continuous uniform moisture-impermeable film free from pinholes and shall adhere satisfactorily to the surfaces of damp concrete. It shall, when applied to the damp concrete surface at the specified rate of coverage, dry to touch in one(1)-hour and dry through in not more than 4-hours under normal conditions suitable for concrete operations. It shall adhere in a tenacious film without running off or appreciably sagging. It shall not disintegrate, check, peel or crack during the required curing period.

The compound shall not peel or pick up under traffic and shall disappear from the surface of the concrete by gradual disintegration.

The compound shall be delivered to the job site in the manufacturer's original containers only, which shall be clearly labeled with the manufacturer's name, the trade name of the material and a batch number or symbol with which test samples may be correlated.

When tested in accordance with ASTM C156 Water Retention by Concrete Curing Materials, the liquid membrane-forming compound shall restrict the loss of water present in the test specimen at the time of application of the curing compound to not more than 0.55-grams-per-square-centimeter (0.01-oz.-per-in_2) of surface.

303.2.13.1.2. Cotton Mats. The cotton mats used for curing shall meet the following requirements: Each mat shall have a finished width of approximately 5-ft. 6-in. (1.7m); and after shrinkage shall be at least 6-in. (15cm) longer than the width of the concrete to be cured.

The mats shall be composed of a single layer of cotton filler, completely enclosed in a cover of cotton cloth. The cotton filler shall be of low-grade cotton, cotton linters of such shall contain not less than ¾-pound (0.34kg) of cotton filler per square-yard of mat, uniformly distributed. The cotton cloth used for covering material shall be Osnaburg, weighing not less than $6_3/_{10}$-ounces-per-square-yard (0.21-kg-per-sq.-m).

All mats shall be stitched longitudinally with continuous parallel rows of stitching at intervals of not more than 4-in. (10cm) or shall be tufted both transversely and longitudinally at intervals of not more than 3-in. (7.6cm). The sewing or tufting shall not be done so tightly that the mat shall not contact the surface of the concrete at all points when saturated with water.

To insure the complete covering of the concrete where the mats fit together, there shall be a flap extending all along one side of each mat. This flap shall be composed of two thicknesses of the cover material and shall be at least 6-in. (15cm) in width.

303.2.13.1.3. Waterproof Paper. Waterproof paper shall consist of two sheets of plain kraft paper cemented together with a bituminous material in which are imbedded cords or strands of fiber running in both directions of the paper, not more than 1¼-in. (3cm) apart. The paper shall be light in color; shall be free of visible defects; and shall have a uniform appearance. It shall be sufficiently strong and tough to permit its use under the conditions existing on streets and structural work without tearing or otherwise becoming unfit for the use for which it is intended. The paper shall conform to specifications for ASTM C171 Sheet Materials for Curing Concrete.

When tested in accordance with ASTM C156 Water Retention by Concrete Curing Materials, the paper shall restrict the loss of water present in the test specimen at the time of application of the waterproof paper to not more than 0.055-grams-per-square-centimeter of surface.

303.2.13.1.4. Polyethylene Film. Polyethylene film shall be opaque pigmented white in color; and shall be manufactured from virgin resin without additives or scrap. The film shall have a minimum thickness of 4-mils (0.004-in.). The permissible moisture loss from the concrete, when tested in accordance with ASTM C156 Water Retention by Concrete Curing Materials, shall not exceed 0.055-grams-per-square-centimeter of surface. The film shall be sufficiently strong and tough to permit its use under the conditions existing on paving or structural projects without being torn or otherwise rendered unfit for the use intended during the curing period. It shall be of uniform thickness throughout, free of pinholes and other blemishes.

303.2.13.2. Rejection. Concrete curing materials may be rejected for failure to meet any of the requirements of this specification.

303.2.14. Joint Sealant. Joint sealing compound shall consist of hot poured polymer or ready-mixed coldapplied sealant, or other material approved by the CITY. It shall not crack or break when exposed to low temperatures. The cured sealant must not pick up or "track" at elevated road temperature.

303.2.14.1. Materials.

303.2.14.1.1. Hot Poured Polymer. The joint sealing compound shall melt to the proper consistency for pouring and shall solidify on cooling to atmospheric temperatures. At no time shall the material be heated to temperature exceeding 450°F (232°C); any material heated above 450°F shall be rejected.

Hot poured polymer shall be tested in accordance with TxDOT Test Method Tex-525-C Tests for Asphalt and Concrete Joint Sealers and shall meet the requirements in Table 303.2.14.1.1.(a) Hot Poured Polymer Sealant Requirements.

Table 303.2.14.1.1.(a) Hot Poured Polymer Sealant Requirements

Property	Test Parameters	Required Result
Penetration	32°F (0°C), 7-oz. (200-grams), 60-sec.	Minimum 0.1-in. (0.25-cm)
	77°F (25°C), 5-oz. (150-grams), 5-sec.	0.45- to 0.3-in. (1.1- to 0.75-cm)
Flow	5-hours, 140°F (60°C), 75° incline	Maximum 0.2-in. (0.5-cm)
Bond extension	15°F (-9°C), 5-cycles	no cracking of the joint sealing material or break in the bond between the joint sealer material and the mortar pieces

303.2.14.1.2. Ready-Mixed Cold-Applied. This sealant shall be a single component and shall consist of a homogeneous blend of asphalt emulsion, polymer, and inert filler. The material shall be a resilient, adhesive compound capable of effectively sealing properly cleaned joints and cracks in concrete and asphalt pavements against infiltration of moisture throughout repeated cycles of contraction and expansion and which shall not be picked up by vehicle tires, particularly at summer temperatures.

This Item covers an emulsion composed principally of a semi-solid asphalt base, water and emulsifying agent suitable for sealing cracks at ambient temperatures of 40°F (4°C) and higher. The emulsion shall be modified with a polymer and shall be smooth and homogeneous, with no evidence of polymer separation.

The cold-applied crack sealant shall meet the requirements in Table 303.2.14.1.2.(a) Cold-Applied Sealant Requirements. Material shall be free-flowing down to 40°F (4°C), such that routine pavement joints and cracks are filled to a depth of 1½-in. (3.8cm) without the addition of heat.

The material shall be furnished in 55-gallon drums.

Table 303.2.14.1.2.(a) Cold-Applied Sealant Requirements

Property	Test MethodRequired	Result	
		Minimum	Maximum
Viscosity[1], Brookfield, 77°F	ASTM D2196 Rheological Properties of Non-Newtonian Materials by Rotational (Brookfield type) Viscometer; Method A	6,000 Centipoise	25,000 Centipoise
Storage Stability Test, One-Day	AASHTO T59	-	1-Percent
Sieve Test	AASHTO T59	-	0.10-Percent
Evaporations[2] and Tests on Residue			
Residue	See Note 2.	65-Percent	-
Penetration test on Residue, 77°F, 100g, 5-seconds	AASHTO T49	35 (0.1-mm)	75 (0.1-mm)
Softening Point test on Residue, R.&B.	AASHTO T53	140°F (60°C)	-
Ductility test on Residue, 39.2°F, 5 cm/Min	AASHTO T51	100-cm	-

1. CITY may require Viscosity Profile in lieu of single-spindle viscosity test, in which case the apparent viscosity shall be 10,000.
2. Residue may be obtained by the following evaporation procedure: Mass 200g of sealant into a 1000-ml beaker or a 1-quart can and place in a heating mantle designed for a 1000-ml beaker. During the evaporation the sealant should be stirred frequently to prevent foam-over or local overheating. The temperature shall be maintained between 260°F and 300°F (125°C and 150°C) for 3- to 5-minutes after the material is water free. Pour required specimen.

303.2.14.1.3. Thermoplastic Cold-Applied. If approved by the CITY, thermoplastic cold-applied jointing material may be used according to manufacturer's recommendations.

303.2.14.2. Rejection. Materials may be rejected for failure to meet any of the requirements of this specification.

303.2.15. Elastomeric Materials. This material shall conform to the requirements of the TxDOT Item 435 Elastomeric Materials. This item shall govern for the materials, testing and fabrication of elastomeric materials, except as otherwise covered in other specifications or on the plans.

303.2.15.1. Rejection. Elastomeric materials may be rejected for failure to meet any of the requirements of this specification.

303.3. MIX DESIGN AND MIXING CONCRETE FOR PAVEMENT

303.3.1. Description. This section shall govern for the concrete in pavements.

303.3.2. Equipment. All machinery and equipment necessary for the prosecution of the work specified herein shall be on the project and shall be approved by the CITY as to condition before the CONTRACTOR shall be permitted to begin operations on which the machinery or equipment is to be used. All machinery and equipment shall be maintained in good condition to insure the completion of the work without excessive delays for repairs and replacements.

303.3.3. Concrete Mix Design and Control. At least 10-days prior to the start of concrete paving operations, the CONTRACTOR shall submit to the CITY a design of the concrete mix it proposes to use together with samples, if requested, of all materials to be incorporated into the mix and a full description of the source of supply of each material component. The proposed batch designs must be submitted to the Engineer on the approved form.

The design of the concrete mix shall produce a quality concrete complying with these specifications and meet the requirements of ACI 318 (1992) - PART 3 Construction Requirements, CHAPTER 5, Concrete Quality, except as amended by these provisions. The concrete mix design shall include the following information:

(1) Design Requirements and Design Summary
(2) Material source
(3) Dry weight of cement/cu. yd. and type
(4) Dry weight of fly ash/cu. yd. and type, if used
(5) Saturated surface dry weight of fine and coarse aggregates/cu. yd.
(6) Design water/cu. yd.
(7) Quantities, type, and name of admixtures with manufacturer's data sheets
(8) Current strength tests or strength tests in accordance with ACI 318
(9) Current Sieve Analysis and -200 Decantation of fine and coarse aggregates and date of tests
(10) Fineness modulus of fine aggregate
(11) Specific Gravity and Absorption Values of fine and coarse aggregates
(12) L.A. Abrasion of coarse aggregates

All material samples submitted to the CITY shall be sufficiently large to permit laboratory batching for the construction of test specimens to check the adequacy of the design. When the CITY has approved the design mix, there shall be no change or deviation from the proportions thereof or sources of supply except as hereinafter provided. No concrete may be placed on the job site until the mix design has been approved by the CITY in writing to the CONTRACTOR.

303.3.4. Quality of Concrete.

303.3.4.1. Consistency. In general, the consistency of concrete mixtures shall be such that:

(1) the mortar shall cling to the coarse aggregate,
(2) the aggregate shall not segregate in concrete when it is transported to the place of deposit,
(3) the concrete, when dropped directly from the discharge chute of the mixer, shall flatten out at the center of the pile, but the edges of the pile shall stand and not flow,
(4) the concrete and mortar shall show no free water when removed from the mixer,
(5) the concrete shall slide and not flow into place when transported in metal chutes at an angle of 30° with the horizontal, and
(6) the surface of the finished concrete shall be free from a surface film or laitance.
(7) The concrete shall be uniform and workable.

The consistency of the concrete as placed should allow the completion of all finishing operations without the addition of water to the surface. When field conditions are such that additional moisture is needed for the final concrete surface finishing operation, the required water shall be applied to the surface by fog spray only; and shall be held to a minimum amount. The concrete shall be workable, cohesive, possess satisfactory finishing qualities

and be of the stiffest consistency that can be placed and vibrated into a homogeneous mass. Excessive bleeding shall be avoided.

If the strength or consistency required for the class of concrete being produced is not secured with the minimum cement specified or without exceeding the maximum water/cement ratio, the CONTRACTOR may use, or the CITY may require, an approved cement dispersing agent (water reducer); or the CONTRACTOR shall furnish additional aggregates, or aggregates with different characteristics, or the CONTRACTOR may use additional cement in order to produce the required results. The additional cement may be permitted as a temporary measure, until aggregates are changed and designs checked with the different aggregates or cement dispersing agent.

The CONTRACTOR is solely responsible for the quality of the concrete produced. The CITY reserves the right to independently verify the quality of the concrete through inspection of the batch plant, testing of the various materials used in the concrete and by casting and testing concrete cylinders or beams on the concrete actually incorporated in the pavement.

303.3.4.2. Standard Classes. Unless otherwise shown on the plans or detailed specifications, the Standard Classes of Pavement Concrete shown in Table 303.3.4.2.(a) shall be used.

Streets, alleys, driveways, and inlets shall be constructed in accordance with these specifications using the classes of concrete, machine or hand finished, whichever is appropriate. Mass pour medians, noses, and islands shall use hand-finished concrete.

The testing does not in any way change the penalties imposed on the CONTRACTOR for deficient strength outlined elsewhere in these specifications.

Table 303.3.4.2.(a) Standard Classes of Pavement Concrete.

Class of Concrete[1]	Minimum Cementitious Lb./CY	28 Day Min. Compressive Strength[2] psi	28 Day Min. Beam Strength[2,3] psi	Maximum Water/ Cementitious Ratio	Coarse Aggregate Maximum Size[4]
A[5]	470	3000	500	0.58	1½”
C	564	3600	600	0.53	1½”
P1[6]	517	4000	N/A	0.49	1½”
P2[7]	564	4500	N/A	0.45	1½”
M	As directed by the OWNER or as shown on the plans				

1. All exposed horizontal concrete shall have entrained – air.
2. Minimum Strength Required by CITY [Compressive or Flexural]
3. ASTM C78 (Third-Point); Reduce by 10% when Type II Cement is Used
4. Smaller nominal maximum size aggregate may be used if strength requirement is satisfied
5. Sidewalks, separate curb and gutter, and 4-inch thick median pavement
6. Machine Finished
7. Hand Finished

303.3.4.3. Performance Classes. Performance Classes of structural concrete shall meet the requirements in Table 303.3.4.3.(a) Performance Classes of Pavement Concrete.

Table 303.3.4.3.(a) Performance Classes of Pavement Concrete

Class of Concrete[1]	Minimum Cementitious Lb./CY	28-Day Compressive Strength psi	28-Day Flexural Strength[2,3] psi	Maximum Water/ Cementitious Ratio[4]	Coarse Aggregate Maximum Size[5]
PA	423	3000[6]	425	0.58	1½"
PC	517	3600[6]	510	0.53	1½"
PP1[7]	517	4000	N/A	0.48	1½"
PP2[8]	564	4500	N/A	0.44	1½"
PM	As directed by the CITY or as shown on the plans				

1. All exposed horizontal concrete shall have entrained – air.
2. ASTM C78 (Third-Point); Reduce by 10% when Type II Cement is used
3. For early form removal
4. Consistent with ACI 211.1 Table 6.3.4(a) Relationship between water-cementitious materials ratio and compressive strength of concrete
5. Smaller nominal maximum size aggregate may be used if Strength requirement is satisfied
6. Calculated Average Required Compressive Strength Considering ACI 318 - Sec. 5.3.2.1 shall be strength shown times 1.15
7. Machine Finish
8. Hand Finish

303.3.4.4. Slump. Slump requirements for pavement and related concrete shall be as specified in Table 303.3.4.4.(a) Pavement Concrete Slump Requirements. No concrete shall be permitted with slump in excess of the maximums shown. Any concrete mix failing to meet the above consistency requirements, although meeting the slump requirements, shall be considered unsatisfactory, and the mix shall be changed to correct such unsatisfactory conditions.

Table 303.3.4.4.(a) Structural Concrete Slump Requirements.

Concrete Use	Avg. Slump (in.)	Max. Slump (in.)
Slip Form Paving	3	4
Hand formed paving	4	5
Sidewalk, Separate Curb and Gutter, and Other Miscellaneous Concrete	As specified by CITY	

303.3.5. Mixing and Delivery. The concrete shall be produced in an approved method conforming to the requirements of this specification and ASTM C94/C94M Standard Specification for Ready-Mixed Concrete or National Ready-mixed Concrete Association (NRMCA). Ready-mix concrete shall be permitted in lieu of the paver-mixer. When ready-mix concrete is used, sampling provisions of ASTM C94 Alternate Procedure 2 shall govern. If fiber-reinforced concrete is used, mixing shall be in accordance with ASTM C1116 Fiber-Reinforced Concrete and Shotcrete. All materials for concrete placed in pavements shall conform to the requirements of the governing item of this specification.

303.3.5.1. Batch Mixing. The concrete shall be mixed in a batch mixer and only in such quantities as are required for immediate use. The mixing of each batch, after all materials are in the drum, shall continue until it produces a thoroughly mixed concrete of uniform mass as determined by established mixer performance ratings and inspection, or appropriate uniformity tests as described in ASTM C94. The entire contents of the drum shall be discharged before any materials are placed therein for the succeeding batch. Retempering or remixing shall not be permitted.

303.3.5.1.1. Mixer. The mixer shall produce concrete of uniform consistency and appearance.

303.3.5.1.2. Cleaning. The mixer shall be cleaned thoroughly each time when out of operation for more than 30 minutes.

303.3.5.2. Transit Mixing. When transit mixing is used, the transit mixer shall be of an approved revolving drum or revolving blade type so constructed as to produce a thoroughly mixed concrete with a uniform

distribution of the materials throughout the mass and shall be equipped with a discharge mechanism which shall insure the discharging of the mixed concrete without segregation.

303.3.5.2.1. Prevention of Leaking. The mixer drum shall be watertight when closed and shall be equipped with a locking device that shall automatically prevent the discharging of the mixer prior to receiving the required number of revolutions.

303.3.5.2.2. Mixing. The entire quantity of mixing water shall be accurately measured by a visible calibrated mechanism. Leaking water valves shall be considered as ample reason for condemnation of the mixer unit and removal from the job by the CITY. Each batch shall be mixed not less than 70 nor more than 100 revolutions at the rate of rotation specified by the manufacturer as mixing speed. Any additional mixing shall be done at a slower speed specified by the manufacturer for agitation and shall be continuous until the batch is discharged.

303.3.5.2.3. Counters. Truck mixers shall be equipped with actuated counters by which the numbers of revolutions of the drum may be readily verified. The counters shall be actuated at the time of starting mixing at mixing speeds.

303.3.5.2.4. Delivery. The rate of delivery of the mixed concrete shall be such that the interval between loads shall not exceed 10-minutes. The concrete shall be delivered to the site of the work and discharged from the mixer before the drum has been revolved 300 revolutions, after the introduction of the mixing water with the dry materials.

303.3.5.3. Central Mixing Plant. A central mixing plant shall be allowed, provided the method of mixing and handling has first been approved by the CITY.

303.3.5.4. Commercial Concrete Plants. In the event the CONTRACTOR elects to use concrete produced by a commercial concrete plant, an agreement shall be drawn and executed by the responsible executive management of said plant granting the CITY ingress and egress to all parts of the plant with full authority to make any and all required tests of aggregates and to regulate and control all batching plant and/or central mixing plant operations. This regulatory control shall be applicable only to the concrete produced by the commercial plant for the payment herein specified.

303.3.5.5. Delivery Tickets. For transit mix operations, the manufacturer of the concrete shall, before unloading, furnish to the purchaser with each batch of concrete at the site a delivery ticket on which is printed, stamped, or written, the following information to determine that the concrete was proportioned in accordance with the approved mix design:

(1) Name of concrete supplier
(2) Serial number of ticket
(3) Date
(4) Truck number
(5) Name of purchaser
(6) Specific designation of job (name and location)
(7) Specific class, design identification and designation of the concrete in conformance with that employed in job specifications
(8) Amount of concrete in cubic yards (or cubic meters)
(9) Time loaded or of first mixing of cement and aggregates
(10) Water added by receiver of concrete and his/her initials
(11) Weight of cement
(12) Weight of fly ash
(13) Type and amount of admixtures
(14) Information necessary to calculate the total mixing water added by the producer (total mixing water includes free water on the aggregates, water and ice batched at the plant, and water added by the truck operator from the mixer tank);
(15) Maximum size of aggregate
(16) Weights of fine and coarse aggregate

For on-site concrete plant operations, the CONTRACTOR shall supply to the CITY a batch ticket with the following information and for each continuous paving operation, provide receipts and invoices to substantiate the amounts of cement and fly ash used in the placement.

(1) At the beginning of each day's placement, a list of the actual batch weights to be used shall be given to the CITY.
(2) When any changes are made, a new list of weights shall be given to the CITY.

303.4. EQUIPMENT

303.4.1. General. All equipment necessary for the construction of this item shall be on the project and shall be approved by the CITY as to condition before the CONTRACTOR shall be permitted to begin construction operations on which the equipment is to be used.

303.4.2. Field Laboratory. A field laboratory structure shall be required only when specifically required and provided for in the special provisions.

303.4.3. Slip Form Paver. Slip form paving equipment shall be provided with traveling side forms of sufficient dimensions, shape and strength so as to support the concrete laterally for a sufficient length of time during placement to produce pavement of the required cross section. The equipment shall spread, consolidate, screed and float-finish the freshly placed concrete in such a manner as to provide a dense and homogeneous pavement.

303.4.4. Forms. The side forms shall be metal, of approved cross section and bracing, of a height not less than the prescribed edge thickness of the concrete section, and a minimum of 10-ft. (3m) in length for each individual form. Forms shall be of ample strength and shall be provided with adequate devices for secure setting so that when in place they shall withstand the impact and vibration of equipment imposed thereupon without appreciable springing or settlement. In no case shall the base width be less than 8-in. (20cm) for a form 8-in. (20cm) or more in height. The forms shall be free from warps, bends or kinks and shall show no variation from the true plane for face or top. Each 10-ft. (3m) length of forms shall be provided with at least 3 pins for securely staking in position. Sufficient forms shall be provided for satisfactory prosecution of the work. 10-ft. (3m) metal form sections shall be used in forming curves with a 250-ft. (75m), and larger radius. For curves with a radius of less than 250-ft. (75m), acceptable flexible metal forms or wood forms may be used upon approval by the CITY.

303.4.5. Mechanical Vibratory Equipment. All concrete placed for pavement shall be consolidated by approved mechanical vibrators operated ahead of the transverse finishing machine and designed to vibrate the concrete internally and/or from the surface. Unless otherwise shown on the plans, vibrators of the surface-pan type shall be used for full-depth placement. Both types of vibrators shall be furnished and may be used concurrently at the discretion of the CITY. Vibratory members shall extend across the pavement practically to,
but shall not come in contact with, the side forms. Mechanically-operated vibrators shall be mounted in such a manner as not to interfere with the transverse or longitudinal joints.

The internal-type vibrators shall be spaced at not more than 24-in. (61cm) and shall be equipped with synchronized vibratory units. Separate Vibratory units shall be spaced at sufficiently close intervals to provide uniform vibration and consolidation to the entire width of the pavement. The frequency in air of the internal spudtype Vibratory units shall be not less than 8,000-cycles-per-minute and not less than 5,000-cycles-per-minute for tube types. The method of operation shall be as directed by the CITY. The CONTRACTOR shall have a
satisfactory tachometer available for checking the vibratory elements.

The pavement vibrators shall not be used to level or spread the concrete but shall be used only for purposes of consolidation. The vibrators shall not be operated where the surface of the concrete, as spread, is below the elevation of the finished surface of the pavement, except for the first lift of concrete where the double strike-off method of placement is employed. The vibrators shall not be operated for more than 15-seconds while the machine upon which they are installed is still.

The pan-type vibrator units shall apply the vibrating impulses directly to the surface of the concrete. The operating frequency shall not be less than 3,500-cycles- nor more than 4,200-cycles-per-minute in air. The CONTRACTOR shall have a satisfactory tachometer available for checking the speed of the vibratory elements.

Approved hand manipulated mechanical vibrators shall be furnished in the number required for provision of proper consolidation of the concrete along the forms, at joints and in areas not covered by mechanically controlled vibrators. These vibrators shall be sufficiently rigid to insure control of the operating position of the vibrating head.

Complete and satisfactory consolidation of the concrete pavement is a most important requirement of this specification. Cores taken as required by Item 303.8. Pavement Testing shall be carefully examined for voids, honeycombing or other evidence of incomplete consolidation. If such evidence is present, changes in the consolidation procedures and/or equipment shall be made to insure satisfactory consolidation.

303.4.6. Vibrating Screed. The mechanically vibrated screed shall be provided with a template adjusted to the crown of the concrete section. The template shall be power vibrated, adjustable in height and mounted to ride on the forms. The mechanical vibration of one of the screeds on the transverse finishing machine specified in Item 303.4.7. Transverse Finishing Machine shall be acceptable.

303.4.7. Transverse Finishing Machine. The transverse finishing machine shall be provided with two screeds accurately adjusted to the crown of the pavement, shall be power driven and mounted in a substantial frame equipped to ride on the forms. The machine shall be so designed and operated as to strike off and consolidate the concrete.

Finishing machines shall be maintained in a tight and good operating condition, accurately adjusted to the required crown or profile and free from deflection, wobble or vibration tending to affect the surface finish. Machines failing to meet these requirements shall be rejected by the CITY, and the CONTRACTOR shall provide approved equipment.

303.4.8. Miscellaneous Finishing Equipment. The CONTRACTOR shall furnish a broom of the push broom type not less than 18-in. (45cm) in width with stiff bristles for the final surface finish of concrete base or as the CITY directs.

The CONTRACTOR shall furnish a sufficient number of bridges equipped to ride on the forms and span the pavement for finishing operations and for the installation and finishing of joints. The CONTRACTOR shall furnish, operate and maintain at least two standard 10-ft. (3m) steel straightedges and all necessary finishing and edging tools as may be required to complete the pavement in accordance with the plans and specifications.

303.5. CONSTRUCTION METHODS

303.5.1. Subgrade. When manipulation or treatment of subgrade is required on the plans, the work shall be performed in proper sequence with the preparation of the subgrade for pavement.

The roadbed shall be excavated and shaped in conformity with the typical sections and to the lines and grades shown on the plans or established by the CITY. Material excavated in the preparation of the roadbed in excess of that needed to properly construct the subgrade, shoulders, slopes or parkway shall be wasted. If additional material is required, it shall be secured from sources indicated on the plans or designated by the CITY. All holes, ruts and depressions shall be filled with suitable material and, if required, the subgrade shall be thoroughly wetted and reshaped. Irregularities of more than ½-in. (13-mm), as shown by straightedge or template, shall be corrected. The subgrade shall be uniformly compacted to at least 95-percent of the maximum density as determined by ASTM D698 Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft_3 (600 kN-m/m_3)). Moisture content shall be within minus-2%- to plus-4%-of-optimum. The prepared subgrade shall be wetted down sufficiently in advance of placing the pavement to insure its being in a firm and moist condition for at least 2-in. (5cm) below the surface. Sufficient subgrade shall be prepared in advance to insure satisfactory prosecution of the work. No hauling or equipment shall be permitted on the finished subgrade.

The CONTRACTOR shall notify the CITY at least three working days in advance of its intention to place concrete pavement.

Density tests must be taken no more than 72-hours prior to placement of concrete. After the specified moisture and density are achieved, the CONTRACTOR shall maintain the subgrade moisture and density in accordance with Item 301. Subgrade, Subbase, and Base Preparation until the pavement is placed. In the event that rain or other conditions may have adversely affected the condition of the subgrade or base, additional tests may be required as directed by the CITY.

303.5.2. Placing and Removing Forms. Forms shall be set to line and grade at least 200-ft. (60m), where practicable, in advance of the paving operations. Forms shall be adequately staked with at least three pins per 10-ft. (3m) section and capable of resisting the pressure of concrete placed against them and the thrust and the vibration of the construction equipment operating upon them without appreciable springing or settlement. Forms shall be jointed neatly and tightly and set with exactness to the established grade and alignment. Forms must be in firm contact with the subgrade throughout their length and base width. If the subgrade becomes unstable, forms shall be reset, using heavy stakes, or other additional supports may be necessary to provide the required stability.

303.5.2.1. Settling. When forms settle over ~-in. (3mm) under finishing operations, paving operations shall be stopped, the forms reset to line and grade and the pavement then brought to the required section and thickness.

303.5.2.2. Cleaning and Oiling. Forms shall be thoroughly cleaned after each use and well oiled before reuse.

303.5.2.3. Removal. Forms shall remain in place until the concrete has taken its final set. At the time the forms are removed, earth shall be banked against the sides of the slab and immediately and thoroughly wetted.

303.5.2.4. Curb. Superimposed or monolithic curb shall be formed from the flowline of the gutter to the top of the curb. All expansion joints in the curbs shall conform to the joint locations in the slab.

303.5.3. Placing Reinforcing Steel, Tie, and Dowel Bars. When reinforcing steel, welded wire mesh, tie bars, dowels, etc., are required, they shall be placed as shown on the plans. All reinforcing shall be clean, free from rust in the form of loose or objectionable scale, and of the type, size and dimensions shown on the plans. Reinforcing bars shall be securely wired together at the alternate intersections and all splices and shall be

securely wired to each intersection dowel and load-transmission unit intersected. All bars shall be installed in their required position as shown on the plans.

The storing of reinforcing or structural steel on completed roadway slabs generally shall be avoided and, where permitted, such storage shall be limited to quantities and distribution that shall not induce excessive stresses.

303.5.3.1. Installation. All reinforcing bars and bar mats shall be installed in the slab at the required depth below the finished surface and supported by and securely attached to bar chairs installed on prescribed longitudinal and transverse centers as shown by sectional and detailed drawings on the plans. After the reinforcing steel is securely installed above the subgrade, as specifically required by plans and as herein prescribed, there shall be no loading imposed upon (or walking upon) the bar mats or individual bars before or during the placing or finishing of the concrete.

303.5.3.2. Welded Wire Mats. Where welded wire fabric reinforcement mats are required by the plans, or permitted as an alternate by the CITY, the concrete shall be placed and struck off by means of a template to the depth below the finished surface as specified for the location of the mesh. Welded wire mats, conforming to the specified side lap and end splice requirements as detailed on the plans, shall be placed upon the struck surface. The remainder of the concrete shall be placed thereupon with finishing operations proceeding immediately. There shall be no loading imposed upon the mesh mats after installation in the slab concrete.

303.5.3.3. Assembly. Expansion joints or dummy joints which may require an assembly of parts supported by special devices shall be completely assembled and rigidly supported in the correct position well in advance of the placing of concrete.

303.5.4. Joints.

303.5.4.1. Joint Dimensions. The width of the joint shall be shown on the plans, creating the joint sealant reservoir. The depth of the joint shall be shown on the plans. Dimensions of the sealant reservoir shall be in accordance with manufacturer's recommendations. Normal width/depth ratios are 1 to 1, not to exceed 1 to 1½. After curing, the joint sealant shall be ~-in. (3mm) to ¼-in. (6mm) below the pavement surface at the center of the joint.

303.5.4.2. Expansion Joints. Expansion joints shall be installed perpendicularly to the surface and to the centerline of the pavement at the locations shown on the plans.

303.5.4.2.1. Joint Filler. Joint filler shall be as specified in Item 303.2.12. Joint Filler, as approved by CITY, of the size and shape shown on the plans.

Board joint material with less than 25-percent of moisture at the time of installation shall be thoroughly wetted on the job. Green lumber of much higher moisture content is desirable and acceptable.

The joint filler shall be appropriately drilled to admit the dowel bars when required. The bottom edge of the filler shall extend to or slightly below the bottom of the slab. The top edge shall be held approximately ½-in. (13mm) below the finished surface of the pavement in order to allow the finishing operations to be continuous. Where the joint filler is of a premolded asphaltic type, the top edge shall be protected, while the concrete is being placed and finished, by a metal cap of at least 10 gauge material having flanges not less than 1½-in. (38mm) in depth. The channel cap may remain in place during the joint finishing operations to serve as a guide for tooling the edges of the joint. After the removal of the side forms, the ends of the joints at the edges of the slab shall be carefully opened for the entire depth of the slab.

303.5.4.2.2. Curb. Where a superimposed curb or a separate curb and gutter may be used, the expansion joints therein shall coincide and be continuous with the pavement joint and of the same size and type.

303.5.4.2.3. Proximity to Existing Structures. When the pavement is adjacent to or around existing structures, expansion joints shall be constructed in accordance with the details shown on the plans.

303.5.4.2.4. Dowel Bars. Dowel bars, where required on the plans, shall be installed through the predrilled joint filler and rigidly supported in true horizontal and vertical positions by an assembly of bar chairs and dowel holders welded to transverse bars extending across the slab and placed on each side of the joint. The chair assembly shall be similar and equal to that shown on the plans and shall be approved by the CITY prior to extensive fabrication.

303.5.4.3. Contraction Joints. Contraction or dummy joints shall be installed at the locations and at the intervals shown on the plans in accordance with this section and Item 402.2. Sawing. The joints shall be constructed by sawing to a ¼-in. (6mm) width and to a depth of ¼ of the pavement thickness, or deeper if so indicated on the plans. Unless otherwise specified on the plans, joints shall be sawed into the completed pavement surface as soon after initial concrete set as possible so that some raveling of the green concrete is observed in order for the sawing process to prevent uncontrolled shrinkage cracking. If sharp edge joints are being obtained, the sawing process shall be sped up to the point where some raveling is observed. Damage by blade action to the slab surface and to the concrete immediately adjacent to the joint shall be minimized.

Any portion of the curing membrane which has been disturbed by sawing operations shall be restored by spraying the areas with additional curing compound. The sawed groove shall immediately be thoroughly cleaned for the full depth and width of the joint and filled. The type of equipment and method for performing this work shall be approved by the CITY.

303.5.4.4. Construction Joints. Construction joints formed at the close of each day's work or when the placing of concrete has been stopped for 30-minutes or longer shall be constructed by use of metal or wooden bulkheads cut true to the section of the finished pavement and cleaned and oiled. Wooden bulkheads shall have a thickness of not less than 1½-in. (38mm). Longitudinal bars shall be held securely in place in a plane perpendicular to the surface and at right angles to the centerline of the pavement. Edges shall be rounded to ¼-in. (6mm) radius. Any surplus concrete on the subgrade shall be removed upon the resumption of the work.

In no case shall an emergency construction joint be placed within 8-ft. (2.4m) following a regular installation of expansion or contraction joint. If the emergency construction joint should fall within this limitation, the concrete shall be removed back to the previously installed joint.

303.5.4.5. Longitudinal Parting Strips. Longitudinal parting strips or planes of weakness, when required, shall be accurately placed as shown on the plans.

303.5.4.6. Longitudinal Construction Joints. Longitudinal construction joints shall be of the type shown on the plans. Longitudinal joints shall be constructed accurately to required lines in order to coincide with traffic lane lines. No width between longitudinal construction joints shall exceed 24-ft. (7.2m), unless specifically authorized or directed by the CITY in writing.

303.5.4.7. Random Drying Shrinkage Cracks and Stress Cracks. Random drying shrinkage cracks or stress cracks of widths greater than 0.025-inches (0.6mm) in recently placed reinforced Portland cement concrete pavement placed on stabilized subbase or slabs on grade are subject to being removed and replaced at the discretion of the CITY. Random drying shrinkage cracks or stress cracks of any nature in recently placed non-reinforced Portland cement concrete pavement placed on non-stabilized subbase or slabs on grade are subject to being removed and replaced at the discretion of the CITY. Recently placed concrete pavement or slabs on grade are those for which the one-year maintenance bond has not expired. Routing, by any means, and sealing random cracks will not be permitted. When Portland cement concrete pavement or slabs on grade must be removed and replaced, the area of removal must extend from the nearest contraction or dummy joint or construction joint a minimum distance of 10-feet (3m), measured parallel to the longitudinal axis of the pavement, and include that portion of the concrete pavement or slab on grade containing the random crack. A sawed dummy joint will be required to be sawed across the opposing, non-damaged, slab in line with the saw cut made for the removal of the damaged slab. The area of removal and replacement of slabs containing longitudinal random cracks will be determined by the CITY or its representative. Randomly cracked Portland cement concrete sidewalks will require removal and replacement of only the five-feet long section or sections containing random cracks.

303.5.4.8. Joint Sealing. Routine pavement joints shall be filled to a depth of 1½-in. (3.8cm). Materials shall generally be handled and applied according to the manufacturer's recommendations, with additional requirements as stated herein.

303.5.4.8.1. Hot Poured Polymer. The sealing filler shall be melted in an approved oil-batch kettle with continuous mechanical agitation. The kettle shall be equipped with temperature indicators. The CITY shall determine the optimum temperature for proper pouring fluidity, and the CONTRACTOR shall maintain the material within close range of optimum temperature. At no time shall the temperature exceed 450°F (232°C). Joint sealing compound shall not be poured at atmospheric temperatures below 32°F (0°C).

303.5.4.8.2. Ready-Mixed Cold-Applied. Permeation of joints shall principally be achieved without the task of squeegeeing. However, squeegeeing is recommended to assist permeation and to allow sealant to become rapidly tack-free. Sealant shall "set" in a fixed position within 40-minutes after application, to where traffic may be restored to the pavement without the effects of "tracking." "Tracking" shall be averted without the use of topping materials such as sand.

303.5.5. Placing Concrete. Unless otherwise shown on the plans, the concrete shall be placed using either forms or slipform paver. The concrete shall be rapidly deposited on the subgrade in successive batches and shall be distributed to the required depth and for the entire width of the pavement by shoveling or other approved methods. Any concrete not placed as herein prescribed within the time limits specified in Table 303.5.5.(a) Concrete Placement will be rejected.

Table 303.5.5.(a) Concrete Placement
Temperature –Time Requirements

Concrete Temp (at point of placement)	Max Time - minutes (no retarding agent)	Max Time – minutes (with retarding agent)[1]
Non-Agitated Concrete		
All temperatures	30	45
Agitated Concrete		
Above 90°F	45	75
Above 75 F thru 90°F	60	90
75°F and Below	90	120

1. Normal dosage of retarder

Where bar mats or wire mesh reinforcing is specified, method of concrete placement shall be in accordance with Item 303.5.3. Placing Reinforcing Steel, Tie, and Dowel Bars. Rakes shall not be used in handling concrete. The placing operation shall be continuous. At the end of the day, or in case of unavoidable interruption or delay of more than 30-minutes, a transverse construction joint shall be placed in accordance with Item 303.5.4.4. Construction Joints.

303.5.5.1. Honeycombing. Special care shall be taken in placing and spading the concrete against the forms and at all joints and assemblies so as to prevent honeycombing. Excessive voids and honeycombing in the edge of the pavement, revealed by the removal of the side forms, may be cause for rejection of the section of slab in which the defect occurs.

303.5.5.2. Weather Conditions. Except by specific written authorization of the CITY, no concrete shall be placed when the air temperature is less than 40°F (4°C) and falling but may be placed when the air temperature is above 35°F (2°C) and rising, the temperature being taken in the shade away from artificial heat. When and if such permission is granted, the CONTRACTOR shall furnish sufficient protective material and devices to enclose and protect the fresh concrete in such a way as to maintain the temperature of the air surrounding the fresh concrete at not less than 50°F (10°C) for a period of at least 5-days. It is to be distinctly understood that the CONTRACTOR is responsible for the quality and strength of the concrete placed under any weather conditions. No concrete shall be placed on a frozen subgrade.

303.5.5.3. Time. Concrete shall not be placed before the time of sunrise and shall not be placed later than shall permit the finishing of the pavement during sufficient natural light.

303.5.6. Finishing.

303.5.6.1. Machine. When the concrete has been deposited, it shall be approximately leveled and then struck off to such elevation that, when mechanically screeded and tamped, the concrete shall be thoroughly compacted and finished to the required line, grade and section with all surface voids filled. Where bar mats or wire mesh reinforcing is specified, method shall be in accordance with Item 303.5.3. Placing Reinforcing Steel, Tie, and Dowel Bars.

303.5.6.1.1. Tolerance Limits. While the concrete is still workable, it shall be tested for irregularities with a 10-ft. (3m) straightedge placed parallel to the centerline of the pavement so as to bridge depressions and to touch all high spots. Ordinates measured from the face of the straightedge to the surface of the pavement shall at no place exceed 1/16 inch-per-foot (1-mm-per-20-cm) from the nearest point of contact. In no case shall the maximum ordinate to a 10-ft. (3m) straightedge be greater than ~-in. (3mm). Any surface not within the tolerance limits shall be reworked and refinished.

303.5.6.1.2. Edging. The edges of slabs and all joints requiring edging shall be carefully tooled with an edger of the radius required by the plans at the time the concrete begins to take its “set” and becomes nonworkable. All such work shall be left smooth and true to lines.

303.5.6.1.3. Stamp or Die. All concrete including curbs, curb with gutter, sidewalks, alleys, driveways and structures shall be marked by means of a substantial stamp or die so designed to make an impression in the finish of the concrete. The stamp or die shall designate the firm name or CONTRACTOR and the month and year in which the work was done. The design of the stamp or die shall be approved by the Engineer.

303.5.6.2. Hand. Hand finishing shall be permitted only in intersections and areas inaccessible to a finishing machine. The addition of one-sack of cement per cubic-yard shall be required for all hand finish concrete.

When the hand method of striking off and consolidating is permitted, the concrete, as soon as placed, shall be approximately leveled and then struck off and screeded to such elevation above grade that, when

consolidated and finished, the surface of the pavement shall be at the grade elevation shown on the plans. The entire surface shall then be tamped and the concrete consolidated so as to insure maximum compaction and a minimum of voids. For the strike off and consolidation, both a strike template and tamping template shall be provided on the work. In operation the strike template shall be moved forward with a combined longitudinal and transverse motion and so manipulated that neither end of the template is raised from the forms during the strikingoff process. A slight excess of material shall be kept in front of the cutting edge at all times.

The straightedge and joint finishing shall be as hereinabove prescribed.

303.5.7. Curing. The curing of concrete pavement shall be thorough and continuous throughout the entire curing period. Failure to provide proper curing as herein prescribed shall be considered as sufficient cause for immediate suspension of the paving operations. The curing method as herein specified does not preclude the use of any of the other commonly used methods of curing, and the CITY may approve another method of curing if so requested by the CONTRACTOR. If any selected method of curing does not afford the desired results, the CITY shall have the right to order that another method of curing be instituted. Immediately after the finishing of the surface, the pavement shall be covered with a continuous, uniform water-impermeable coating of the type specified in Item 303.2.13. Curing Materials. After removal of the side forms, the sides of the slab shall receive a like coating before earth is banked against them. The solution shall be applied, under pressure with a spray nozzle, in such a manner as to cover the entire surfaces thoroughly and completely with a uniform film.

The rate of application shall be such as to insure complete coverage and shall not exceed 200-square-feetper-gallon of curing compound. When thoroughly dry, it shall provide a continuous and flexible membrane, free from cracks or pinholes, and shall not disintegrate, check, peel or crack during the curing period. If for any reason the seal is broken during the curing period, it shall be immediately repaired with additional sealing solution.

When tested in accordance with ASTM C156 Water Retention by Concrete Curing Materials, the curing compound shall provide a film which shall have retained within the test specimen a percentage of the moisture present in the specimen when the curing compound was applied according to Table 303.5.7.(a) Water Retention by Curing Materials.

Table 303.5.7.(a) Water Retention by Curing Materials

Time	Minimum Retained Moisture
After 24-hours	97%
After 3-days	95%
After 7-days	91 %

303.5.8. Opening Pavement to Traffic. All traffic shall be excluded from the pavement for a period of not less than 14-days or until field cured test specimens indicate concrete meets at least 75% of design strength, or as otherwise approved by the CITY. In all cases the pavement shall be cleaned and joints shall be filled and trimmed before being opened to traffic.

303.5.8.1. Traffic Access. When it is necessary to provide for traffic across the pavement, the CONTRACTOR shall, at its own expense, construct suitable and substantial crossings over the concrete which shall be adequate for the traffic using same.

303.5.8.2. Time. Opening pavement to traffic shall not relieve the CONTRACTOR of responsibility for the work and shall not in any way affect the time charge on the entire project. The number of days stated in the contract shall govern for the completion of the entire work covered by the contract.

303.5.9. Monolithic Curb. Concrete for monolithic curb shall be the same as for the pavement and, if carried back from the paving mixer, shall be placed within 20-minutes after being mixed. Concrete may be placed from the separate mixer if desired but in any case must be placed while the pavement concrete is still plastic. After the concrete has been struck off and sufficiently set, the exposed surfaces shall be thoroughly worked with a wooden flat. The exposed edges shall be rounded by the use of an edging tool to the radius indicated on the plans. When the concrete in the curb has been sufficiently set, the inside form shall be carefully removed and the surface may be plastered with a mortar consisting of one part of Portland cement and two parts fine aggregate. The mortar shall be applied with a template or “mule” made to conform to curb dimensions. All exposed surfaces of curb shall be brushed to a smooth and uniform surface.

303.5.10. Superimposed Curb. When sawed joints are used, curbs shall be doweled as shown on the plans and poured after sawing. Doweled curbs which are placed with an extrusion machine shall have a mixture that conforms to Item 303.3. Mix Design And Mixing Concrete For Pavement.

303.5.11. Slip Form Paving. At the option of the CONTRACTOR, and with the approval of the CITY, concrete pavement may be constructed by the use of slip form paving equipment.

The concrete, for the full paving width, shall be effectively consolidated by internal vibration with transverse vibrating units or with a series of longitudinal vibrating units loaded with the specified thickness of pavement section and at a minimum distance ahead of the screed equal to the pavement thickness.

When concrete is being placed adjacent to an existing pavement, that part of the equipment which is supported on the existing pavement shall be equipped with protective pads on crawler tracks or rubber-tired wheels offset to run a sufficient distance from the edge of the pavement to avoid breaking or cracking the pavement edge.

Final finishing for slip form pavement construction shall be to the tolerance as specified in Item 303.5.6. Finishing.

303.6. ALLEY PAVING

Alley paving shall be constructed in accordance with the specifications for street paving hereinbefore described, in accordance with the details shown on the plans, and with the following additional provisions:

Alley paving shall be constructed to one of the typical cross sections shown on the plans.

Transverse expansion joints of the type shown on the plans shall be constructed at the property line on each end of the alley with a maximum spacing of 600-ft. (180m). Transverse contraction and dummy joints shall be placed at the spacing shown on the plans. Contraction and dummy joints shall be formed in such a manner that the required joints shall be produced to the satisfaction of the CITY. All joints shall be filled with top seal in accordance with the requirements of Item 303.5.4. Joints.

303.7. PAVEMENT LEAVEOUTS

Pavement leaveouts as necessary to maintain and provide for local traffic shall be provided at location indicated on the plans or as directed by the CITY. The extent and location of each leaveout required and a suitable crossover connection to provide for traffic movements shall be determined in the field by the CITY. Left or rightturn lanes and median openings shall not be considered as pavement leaveouts.

303.8. PAVEMENT TESTING

303.8.1. Testing of Materials. Samples of all materials for test shall be made at the expense of the CITY, unless otherwise specified in the special provisions or in the plans. In the event the initial sampling and testing does not comply with the specifications, all subsequent testing of the material in order to determine if the material is acceptable shall be at the CONTRACTOR'S expense at the same rate charged by the commercial laboratories. All testing shall be in accordance with applicable ASTM Standards and concrete testing technician must be ACI certified or equivalent.

303.8.2. Pavement Thickness Test. Upon completion of the work and before final acceptance and final payment shall be made, pavement thickness test shall be made by the CITY. The number of tests and location shall be at the discretion of the CITY, unless otherwise specified in the special provisions or on the plans. The cost for the initial pavement thickness test shall be the expense of the CITY. In the event a deficiency in the thickness of pavement is revealed during normal testing operations, subsequent tests necessary to isolate the deficiency shall be at the CONTRACTOR'S expense. The cost for additional coring test shall be at the same rate charged by commercial laboratories.

Where the average thickness of pavement in the area found to be deficient in thickness by more than 0.20-in. (5mm), but not more than 0.50-in. (12.5 mm), payment shall be made at an adjusted price as specified in Table 303.8.2.(a) Concrete Pavement Deficiency.

Table 303.8.2.(a) Concrete Pavement Deficiency

Deficiency in Thickness Determined by Cores		Proportional Part of Contract Price
Inches	mm	Allowed
0.00 — 0.20	0.0 — 5.0	100 percent
0.21 — 0.30	5.3 — 7.5	80 percent
0.31 — 0.40	7.8 — 10.0	70 percent
0.41 — 0.50	10.3 — 12.5	60 percent

Any area of pavement found deficient in thickness by more than 0.50-in. (12.5mm) but not more than 0.75-in. (19mm) or $1/10$ of the plan thickness, whichever is greater, shall be evaluated by the CITY. If, in the judgment of the CITY, the area of such deficiency should not be removed and replaced, there shall be no payment for the area retained. If, in the judgment of the CITY, the area of such deficiency warrants removal, the area shall be

removed and replaced, at the CONTRACTOR'S entire expense, with concrete of the thickness shown on the plans. Any area of pavement found deficient in thickness by more than 0.75-in. (19mm) or more than $_1/_{10}$ of the plan thickness, whichever is greater, shall be removed and replaced, at the CONTRACTOR'S entire expense, with concrete of the thickness shown on the plans.

No additional payment over the contract unit price shall be made for any pavement of a thickness exceeding that required by the plans.

303.8.3. Pavement Strength Test.

303.8.3.1. For Standard Classes of Concrete. During the progress of the work, the CONTRACTOR shall cast test cylinders, in accordance with ASTM C31 Standard Practice for Making and Curing Concrete Test Specimens in the Field, to maintain a check on the compressive strengths of the concrete being placed.

In accordance with ASTM C31 and ASTM C172 Standard Practice for Sampling Freshly Mixed Concrete, four test cylinders shall be taken from a representative portion of the concrete being placed for every 150-cubic yards of concrete pavement placed, but in no case shall less than 2 sets of cylinders be taken from any one day's placement.

After the cylinders have been cast, they shall remain on the job site and then transported, moist cured, and tested by the CIT Y in accordance with ASTM C31 and ASTM C39 Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.

In each set, one of the cylinders shall be tested at 7-days, two cylinders shall be tested at 28-days, and one cylinder shall be held or tested at 56-days, if necessary.

If the 28-day test results indicate deficient strength, the CONTRACTOR may, at its option and expense, core the pavement in question and have the cores tested by an approved laboratory, in accordance with ASTM C42 Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete and ACI 318 protocol, except the average of all cores must meet 100% of the minimum specified strength, with no individual core resulting in less than 90% of design strength, to override the results of the cylinder tests.

The CONTRACTOR shall be responsible for the proper storage, maintenance, and any required curing of concrete test samples made by the CITY. The CONTRACTOR shall provide and maintain curing facilities for the purpose of curing concrete test specimens on site in accordance with ASTM C31. The cost of all materials used in test specimens and the cost of storing, maintaining and of providing and maintaining curing facilities will not be paid for as a separate contract pay item, and the costs thereof shall be considered incidental to the contract pay items provided.

Cylinders and/or cores must meet minimum specified strength. Pavement not meeting the minimum specified strength shall be subject to the money penalties or removal and replacement at the CONTRACTOR'S expense as shown in Table 303.8.3.1.(a) Standard Class Concrete Deficiency Penalties.

Table 303.8.3.1.(a) Standard Class Concrete Deficiency Penalties.

Percent Deficient	Percent of Contract Price Allowed
Greater Than 0% — Not More Than 5%	95-percent
Greater Than 5% — Not More Than 10%	90-percent
Greater Than 10% — Not More Than 15%	80-percent
Greater Than 15%	60-percent or removed and replaced at the entire cost and expense of CONTRACTOR as directed by OWNER.

The amount of penalty shall be deducted from payment due to CONTRACTOR; such penalty deducted is to defray the cost of extra maintenance.

The strength requirements for structures and other concrete work are not altered by this special provision. No additional payment over the contract unit price shall be made for any pavement of strength exceeding that required by plans and/or specifications.

303.8.3.2. For Performance Classes of Concrete. During the progress of the work, the CONTRACTOR shall cast test cylinders, in accordance with ASTM C31 Standard Practice for Making and Curing Concrete Test Specimens in the Field, to maintain a check on the compressive strengths of the concrete being placed.

In accordance with ASTM C31 and ASTM C172 Standard Practice for Sampling Freshly Mixed Concrete, four test cylinders shall be taken from a representative portion of the concrete being placed for every 150-cubic yards of concrete pavement placed, but in no case shall less than 2 sets of cylinders be taken from any one day's placement.

After the cylinders have been cast, they shall remain on the job site and then transported, moist cured, and tested by the CITY in accordance with ASTM C31 and ASTM C39 Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.

In each set, one of the cylinders shall be tested at 7-days, two cylinders shall be tested at 28-days, and one cylinder shall be held or tested at 56-days, if necessary.

If the 28 day test results indicate deficient strength, the CONTRACTOR may, at its option and expense, core the pavement in question and have the cores tested by an approved laboratory, in accordance with ASTM C42 Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete and ACI 318 protocol, to override the results of the cylinder tests.

The CONTRACTOR shall be responsible for the proper storage, maintenance, and any required curing of concrete test samples made by the CITY. The CONTRACTOR shall provide and maintain curing facilities for the purpose of curing concrete test specimens on site in accordance with ASTM C31. The cost of all materials used in test specimens and the cost of storing, maintaining and of providing and maintaining curing facilities will not be paid for as a separate contract pay item, and the costs thereof shall be considered incidental to the contract pay items provided.

Cylinders and/or cores must meet the specified strength in accordance with ACI 318 protocol. Pavement not meeting the specified strength shall be subject to the money penalties or removal and replacement at the CONTRACTOR'S expense as shown in Table 303.8.3.2.(a) Performance Class Concrete Deficiency Penalties.

Table 303.8.3.2.(a) Standard Class Concrete Deficiency Penalties.

Percent Deficient	Percent of Contract Price Allowed
Greater Than 0% — Not More Than 5%	95-percent
Greater Than 5% — Not More Than 10%	90-percent
Greater Than 10% — Not More Than 15%	80-percent
Greater Than 15%	60-percent or removed and replaced at the entire cost and expense of CONTRACTOR as directed by OWNER.

The amount of penalty shall be deducted from payment due to CONTRACTOR; such penalty deducted is to defray the cost of extra maintenance.

The strength requirements for structures and other concrete work are not altered by this special provision. No additional payment over the contract unit price shall be made for any pavement of strength exceeding that required by plans and/or specifications.

ITEM 304. SOLID CONCRETE INTERLOCKING PAVING UNITS

304.1. DESCRIPTION

This item shall govern the construction of concrete pavements and medians utilizing interlocking paving units according to lines, grades, locations, and designs as indicated on the plans and specifications, or as established by the Engineer.

304.2. GENERAL

Concrete Interlocking Paving Units are to be used on a site-specific basis only. The Engineer shall specify the special material and construction requirements for each location. Each site-specific application requires proper engineering design for the anticipated traffic volumes and vehicle loads.

304.3. MATERIALS

304.3.1. Concrete Paving Units. Interlocking paving unit construction shall conform to ASTM C936 Solid Interlocking Concrete Paving Units.

Pigment in concrete paving units shall conform to ASTM C979 Pigments for Integrally Colored Concrete.

All units shall be sound and free of defects that would interfere with the proper placing of unit or impair the strength or permanence of the construction.

304.3.1.1. Sampling and Testing Units. Manufacturer shall provide access to lots ready for delivery to the CITY for testing in accordance with ASTM C936 for sampling of material prior to commencement of paving unit placement.

Manufacturer shall provide data showing manufactured products meet or exceed ASTM C936 when tested in compliance with ASTM C140 Sampling and Testing Concrete Masonry Units.

304.3.2. Base. The Engineer shall specify the site-specific requirements for each use. Base for pavements may consist of a reinforced concrete base, asphalt, flexible base or stabilized subgrade. Base for medians shall be site specific and according to design parameters of the Engineer.

304.3.3. Bedding and Joint Sand. Bedding and joint sand shall be clean, non-plastic, and free from deleterious or foreign matter. The sand shall be natural or manufactured from crushed rock. When concrete paving units are subject to vehicular traffic, the sands shall be as hard and angular as practically available. Limestone screenings or stone dust shall not be used. Unevenly graded sand with an excess amount of material passing the No. 200 (75-µm) sieve shall not be used.

Sand that is suitable for the manufacturing of concrete is typically suitable for bedding. Grading of sand samples for the bedding course and joints shall be done according to ASTM C136 Method for Sieve Analysis for Fine and Coarse Aggregate. Bedding sand shall conform to the grading requirements of ASTM C33 Concrete Aggregates as shown in Table 304.3.3.(a) Bedding Sand Gradation.

Table 304.3.3.(a) Bedding Sand Gradation.

Table 304.3.3.(a) Bedding[1] Sand Gradation

Sieve Size	Percent Passing
~-in. (9.5-mm)	100
No. 4 (4.75-mm)	95 to 100
No. 8 (2.36-mm)	85 to 100
No. 16 (1.18-mm)	50 to 85
No. 30 (600-µm)	25 to 60
No. 50 (300-µm)	10 to 30
No. 100 (150-µm)	2 to 10

1. Bedding sand may be used for joint sand. However, extra effort in sweeping and compacting the paving units shall be required to fill the joints completely.

If joint sand other than bedding sand is used, it shall conform to the grading requirements of ASTM C144 Aggregate for Masonry Mortar as shown in Table 304.3.3.(b) Joint Sand Gradation. Joint sand shall not be used for bedding sand. Mason sands are typically acceptable only for joint sand provided they meet grading requirements as shown in Table 304.3.3.(b) Joint Sand Gradation.

Table 304.3.3.(b) Joint Sand Gradation (Natural Sand)

Sieve Size	Percent Passing
No. 4 (4.75 mm)	100
No. 8 (2.36 mm)	95 to 100
No. 16 (1.18 mm)	70 to 100
No. 30 (600 µm)	40 to 75
No. 50 (300 µm)	10 to 35
No. 100 (150 µm)	2 to 15
No. 200 (75 µm)	0

304.3.4. Curbs and Gutters. Edge restraint is a critical design component of interlocking unit pavement. Curbs and gutters for concrete pavement units shall meet the requirements of Item 305.1. Concrete Curb and Gutter with any deviations indicated on the plans or instructed by the Engineer.

304.4. CONSTRUCTION METHODS

Construction methods for each type unit shall be provided by the manufacturer and approved by the Engineer based on the site-specific use. Delivery and paving schedule shall be coordinated to minimize interference with normal use of buildings adjacent to paving.

304.4.1. Delivery, Storage and Handling. Concrete paving units shall be delivered to the site in steel banded, plastic banded, or plastic wrapped cubes capable of transfer by fork lift or clamp lift. Paving units shall be unloaded at job site in such a manner that no damage occurs to the product.

Sand shall be covered with waterproof covering to prevent exposure to rainfall or removal by wind. The covering shall be secured in place.

304.4.2. Environmental Conditions. Paving units shall not be installed during heavy rain or snowfall over frozen base materials. Sand shall not be wet or frozen.

304.4.3. Construction Procedure.

304.4.3.1. Base. Construction methods shall follow the requirements of the selected base as contained in these specifications with any deviations indicated on the plans or instructed by the Engineer.

304.4.3.2. Bedding. Sand shall be spread evenly over the base course and screed to a nominal 1-in. (25mm) thickness, not exceeding 1.5-in. (40mm) thickness. The screeded sand shall not be disturbed. Sufficient sand shall be placed to stay ahead of the laid paving units. Bedding sand shall not be used to fill depressions in the base surface. The material shall be of uniform moisture content when spread.

304.4.3.3. Paving Units and Joints. Paving units shall be free of foreign materials before installation. Paving units shall be laid in the pattern(s) as shown on the drawings. Straight pattern lines shall be maintained.

Joints shall be made according to manufacturer recommendations. Typically, joints between the paving units will be between $_{1}/_{16}$-in. and $_{3}/_{16}$-in. (2mm to 5mm) wide except where paving unit shapes require a larger joint.

Gaps at the edges of the paved area shall be filled with cut paving units or edge units. Cuts shall be made with a mounted masonry saw. Units cut no smaller than one-third of a whole paving unit when feasible are recommended along edges subject to vehicular traffic. Areas not feasible shall be neatly grouted and pointed up.

A low amplitude, high frequency plate vibrator shall be used to vibrate the paving units into the sand. The size of compaction equipment shall be selected according to Table 304.4.3.3.(a) Compaction Equipment.

Table 304.4.3.3.(a) Compaction Equipment

Paving Unit Thickness	Minimum Centrifugal Compaction Force
2.4-in. (60mm)	3000-lbs. (13-kN)
3.1-in. (80mm)	5000-lbs. (22-kN)

Dry joint sand shall be swept into the joints and vibrated until joints are full. This will require at least two or three passes with the vibrator. All work to within 3-ft. (1m) of the laying face must be left fully compacted with sand-filled joints at the completion of each day. Excess sand shall be swept off and removed when the job is com plete.

The final surface elevation of paving units after removal of excess sand shall conform to the plans, shall not deviate more than ~-in. (10mm) under a 10-ft. (3m) long straightedge, and shall be ~-in. to ¼-in. (3- to 6-mm) above adjacent drainage inlets, curb and gutters, concrete collars or channels.

The CONTRACTOR shall resand paving unit joints as necessary for a period of 90-days after completion of work.

ITEM 305. MISCELLANEOUS ROADWAY CONSTRUCTION

305.1. HAND POURED CONCRETE CURB AND GUTTER

305.1.1. Description. Curb and gutter shall be of the type specified and shall be constructed to the size, shape, lines and grade as shown on the plans or as directed by the CITY. Variations in size and shape may be made to fit individual special conditions.

305.1.2. Materials. All materials used in concrete herein specified shall conform to the requirements of the applicable sections of Item 303. Portland Cement Concrete Pavement of these specifications and to additional requirements herein included.

305.1.3. Construction Methods.

305.1.3.1. Excavation. Excavation shall be as provided in Item 203.4. Unclassified Street Excavation, and as shown on the plans. Asphalt millings or extra depth concrete shall be used to correct grade deficiencies identified after subgrade has been checked.

305.1.3.2. Reinforcing Steel. All steel reinforcement shall be accurately placed as shown on the plans and held in place during progress of concreting by such effective means that it shall not be moved out of true position. All bars shall be wired at their intersections and at all laps or splices. All bars at splices shall be lapped a minimum of 20-diameters of the bar or 12-in. (30cm), whichever is greater.

All reinforcement necessary for a section of concrete shall be placed and approved by the CITY before any concrete is deposited in the section. All steel must be free from paint and oil and all loose scale, rust, dirt and other foreign substances shall be completely removed before using.

305.1.3.3. Forms. All forms shall be of wood or steel, straight, free of warp and framed, braced or staked in a substantial and approved manner so as to insure perfect alignment and grade. All forms shall be clean and shall be oiled immediately before concreting. Care shall be taken in removing forms to prevent marring or spalling of the concrete. Forms shall extend the full depth of concrete and be a minimum of $1\frac{5}{8}$-in. (41 mm) in thickness or equivalent when wooden forms are used, or be of a gauge that shall provide equivalent rigidity and strength when metal forms are used.

For curves with a radius of less than 250-ft. (75m), acceptable flexible metal or wood forms shall be used.

All forms showing a deviation of -in. (3mm) in 10-ft. (3m) from a straight line shall be rejected.

305.1.3.4. Expansion Joints. Expansion joints shall be constructed using expansion joint material of an approved type. Expansion joints shall be placed in the curb and gutter at 40 ft. (61 m) intervals and at intersection returns and other rigid structures, or as otherwise specified by the CITY. Tooled joints shall also be placed at 15-ft. (4.5m) intervals or matching abutting sidewalk joints and pavement joints to a depth of ¼ the thickness of the curb. Expansion joints shall also be placed at all intersections with concrete driveways, curbs, buildings and other curbs and gutters. All expansion joints shall be not less than ½-in. (13mm) in thickness, extending the full depth of the concrete and shall be perpendicular and at right angles to the face of the curb. Any expansion material extending above the finished work shall be neatly trimmed to the surface of the finished work. The expansion joints in concrete pavement shall coincide with the expansion joints in the curb and gutter and sidewalk. Longitudinal dowels, across the expansion joints in the curb and gutter, shall be required. There shall be three No. 4 round, smooth bars for dowels at each expansion joint, spaced in accordance with standard reinforcement steel specifications. The dowel shall be a minimum of 24-in. (0.6m) in length. One-half of the dowel shall be coated with asphalt and terminated with an expansion cap. The cap shall provide a minimum of 1-in. (25mm) free expansion. Dowels shall be supported by an approved method to provide a true horizontal and longitudinal alignment.

In the event that concrete pavement is to be placed in the street, the contraction (dummy) joints in the curb, gutter and/or combined curb and gutter shall be in strict alignment with the contraction (dummy) joints in the pavement and may be marked with an approved tool to the depth designated by the CITY. If the joints are not constructed by marking, they shall be sawed at the time of sawing joints in the concrete slab and to the same depth as those in the slab. Expansion joints of the size of those in the pavement shall be placed through the curb and gutter at the point of, and in strict alignment with, expansion joints in the pavement.

All joints through the gutters (not curb) shall be sealed with hot-poured polymer sealer unless otherwise specified.

All joints shall be constructed in a neat and workmanlike manner, with edges rounded, in conformity with the plans and specifications and at location as shown on the plans or as designated by the CITY.

305.1.3.5. Concrete Placement. No concrete shall be placed when the air temperature is less than 35°F (1.7°C), unless permission to do so is granted by the CITY in writing. When such permission is granted, the CONTRACTOR shall furnish sufficient protective material and devices to enclose and protect the fresh concrete in

such a way as to maintain the temperature of the air surrounding the fresh concrete at not less than 45°F (7.2°C) for a period of at least 5-days.

Concrete shall be deposited so as to maintain a horizontal surface and shall be thoroughly and continuously worked into all spaces and around any reinforcement so as to form a dense voidless mass. The coarse aggregate shall be worked away from contact with the forms so as to form a smooth, hard exposed concrete surface.

The concrete for curb and gutter shall preferably be placed continuously between expansion joints. If construction joints are allowed at other locations by the CITY, they shall be properly constructed with wooden bulkheads so as to completely separate adjacent concrete sections.

Integral curb, with or without gutter, when designated in the plans or specifications, shall be placed while the concrete in the base or pavement is still plastic and shall be spaded and consolidated with the concrete slab in order that a thorough bond shall be obtained.

Integral curb, with or without gutter, shall be placed in sections equal to the adjoining concrete slab length, with expansion joints provided as specified herein.

Where curb and gutter is not adjacent to new pavement, 2-in. (5cm) of sand cushion shall be used. After the fine grading has been completed, a 2-in. (5cm) layer of sand or suitable gravel cushion shall be evenly spread over the subgrade for curb and gutter, thoroughly wetted and tamped into place to the satisfaction of the CITY. The forms shall be placed upon this sand or gravel base. A screed shall be used to shape the sand cushion to fit a plane parallel to the top of gutter. A curb and gutter machine may be used, if approved by the CITY.

305.1.3.6. Finishing. After the concrete has been struck off and while it is still plastic, the exposed surfaces may be plastered with ¼-in. (6mm) mortar topping. The mortar topping shall be applied with a steel “mule,” or a finishing tool or method which produces results equivalent to that obtained with the mule. All exposed surfaces shall then be floated or troweled and lightly brushed as required by the CITY to produce a smooth and uniform finish. Excess working of the surfaces shall be avoided. Excess water, laitance and inert materials shall be removed from the surfaces.

The top of all the work and the face of all curbs shall be checked for irregularities as soon as the surface is finished, using a 10-ft. (3m) straightedge, and the maximum distance from the straightedge to the concrete shall not exceed ¼-in. (6mm). All variations greater than ¼-in. (6mm) shall be immediately corrected. All honeycombed areas disclosed by removal of forms shall be immediately chipped out and patched with Portland cement mortar.

305.1.3.7. Curing. After finishing operations are completed, the concrete surface shall be sprayed with concrete curing compound. The surface of the concrete shall be kept thoroughly damp between the completion of the finishing operations and the application of the curing compound. The curing compound shall be applied under pressure, by means of a spray nozzle, at a rate not to exceed 200-sq.-ft.-per-gallon (4.9-m_2-per-L). A minimum of 72-hours curing time shall be required.

Forms shall remain in place at least 24-hours after completion of the concrete placement for the curb and gutter. Should the CONTRACTOR elect to remove the forms before the minimum curing time has elapsed, it shall apply curing compound to the newly exposed vertical faces. Forms for inside curb faces may be removed in approximately 3-hours, provided that the concrete has set sufficiently to permit form removal without curb damage.

305.1.3.8. Finishing Exposed Surfaces. Exposed surfaces of curb and gutter shall receive the type of finish as specified by the CITY in accordance with Item 702.4.13. Finishing Exposed Surfaces.

305.2. CONCRETE SIDEWALKS, DRIVEWAY APPROACHES, AND BARRIER FREE RAMPS

305.2.1. Description. This item shall govern the construction of barrier free access ramps, concrete sidewalks, driveways and approaches conforming to the lines, grades, locations and designs as indicated on the plans and specifications or as established by the CITY.

305.2.2. Materials.

305.2.2.1. Concrete. All materials and requirements for concrete shall conform to the requirements of Item 305.1. Concrete Curb and Gutter.

305.2.2.2. Reinforcement. Driveway approaches No. 3, 12-in O.C.E.W or 6-in x 6-in #10-in wire mesh only when approved by the City of Temple Engineer. Sidewalk reinforcing (except in driveway approach) may be No. 3 bars on 16-in O.C.E.W. or 6-in x 6-in #10 wire mesh.

305.2.3. Construction Methods.

305.2.3.1. General. Concrete sidewalks shall have a minimum thickness of 4-in. (10cm), except that sidewalks constructed in driveway approach sections shall have a minimum thickness equal to that of driveway approach or as called for by plans and specifications within the limits of the driveway approach. Standard slope for walks shall be ¼-in.-per-ft. (20-mm-per-m) in the direction of the curb or street with a tolerance of $_1/_8$-in.-per-ft. (10-mm-per-m). The construction of the driveway approach shall include the variable height radius curb in accordance with the plans and details.

Ramps shall comply with provisions of Texas Accessibility Standards including location, slope, width, shapes, texture and coloring.

At the locations shown on the plans or at locations designated by the CITY, the separate curb, integral curb or curb and gutter shall be laid down to a uniform width of not less than the specified height of the curb from the back of the curb line for access to future driveways. The return radii and partial curb return shall be built from the face of the curb to the back of the curb lay-down.

Where a driveway approach or ramp is to be constructed at a location where there exists a separate curb and gutter, said curb and gutter shall be removed for the full width of the gutter to the nearest joint or to a sawed point at the point of radius. On concrete pavement with monolithic curb, the breakout line shall be 12-in. (300mm) from the face of the curb line and shall be parallel to it and form a right angle with the concrete surface. The breakout line shall be a sawed groove in accordance with the requirements of Item 402.2. Sawing. Alternately, the CITY may approve use of equipment designed to cut concrete curbs. All faces and edges exposed as a result of cutting shall be smoothed.

305.2.3.2. Excavation. Excavation required for the construction of sidewalks and driveways shall be to the lines and grades as established by the CITY or as shown on the plans.

305.2.3.3. Fine Grading. The CONTRACTOR shall do all necessary filling, leveling and fine grading required to bring the subgrade to the exact grades specified and compacted to at least 90-percent of maximum density as determined by ASTM D698 Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)). Moisture content shall be within minus-2- to plus-4-of-optimum. Any over-excavation shall be repaired to the satisfaction of the CITY.

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

305.2.3.5. Reinforcement. Steel bar reinforcement, when required, shall be placed according to the methods in Item 303.2.9. Steel Reinforcement. If wire fabric is permitted, it shall be placed in accordance with Item 303.2.10. Steel Wire Reinforcement.

305.2.3.6 Concrete Placement. Concrete placement shall be in accordance with the relevant provisions of Item 305.1. Concrete Curb and Gutter.

305.2.3.7. Finishing. Concrete sidewalks and driveway approaches shall be finished to a true, even surface. They shall be troweled and then brushed transversely to obtain a smooth uniform brush finish. Joint and sides shall be edged with suitable tools.

305.2.3.8. Joints. Expansion joints for sidewalks and driveways shall be formed using expansion joint material of an approved type and shaped to the section. Expansion joints shall be placed in the sidewalk at 40-ft. (12m) intervals or as otherwise specified by the CITY. Expansion joints shall also be placed at all intersections, sidewalks with concrete driveways, curbs, formations, other sidewalks and other adjacent old concrete work. Similar material shall be placed around all obstructions protruding into or through sidewalks or driveways. All expansion joints shall be ½-in. (13mm) in thickness. Edges of all construction and expansion joints and outer edges of all sidewalks shall be finished to approximately a ½-in. (13mm) radius with a suitable finishing tool. Sidewalks shall be marked at intervals equal to the width of the walk with a marking tool. When sidewalk is against the curb, expansion joints and tooled grooves shall match those in the curb.

305.2.3.9. Curing. Sidewalks and driveways shall be cured in accordance with the requirements of Item 305.1. Concrete Curb and Gutter.

305.3. CONCRETE MEDIANS

305.3.1. Description. This item shall consist of concrete medians in accordance with these specifications and in conformance with the lines and grades established by the CITY and details shown on the plans.

305.3.2. Materials. All material requirements for constructing concrete medians shall conform to the requirements of Item 305.1. Concrete Curb and Gutter. Where a monolithic concrete median is indicated, concrete and reinforcement shall match the adjacent pavement.

305.3.3. Construction Methods.

305.3.3.1. Excavation. Excavation and fine grading shall be done according to Item 203.4. Unclassified Street Excavation, and shall be subsidiary to the item.

305.3.3.2. Forms. Forms, where required, shall conform to the requirements of Item 305.1. Concrete Curb and Gutter and shall be of a depth equal to the depth of the required section. Forms shall be securely staked to line and grade and maintained in a true position during the depositing of concrete.

305.3.3.3. Concrete Placement. Concrete placement shall be in accordance with the relevant provisions of Item 305.1. Concrete Curb and Gutter.

305.3.3.4. Finishing. The surface shall be finished with a float and lightly brushed to obtain a uniform finish. Tooled joints shall be placed longitudinally and transversely at intervals not to exceed 6-ft. (1.8m) center to center, as shown on the plans, or as directed by the CITY. Joints in the median shall coincide with joints in curb and gutter. Expansion joint material shall be placed between the median and the back of curb and around all obstructions protruding through the concrete median.

305.4. REINFORCED CONCRETE HEADERS

305.4.1. Description. This item shall govern the construction of reinforced concrete header to the size, shape and at the location shown on the plans.

305.4.2. Materials. Material requirements shall be the same as those for Item 303. Portland Cement Concrete Paving.

305.4.3. Construction Methods. Concrete header shall be constructed at the location(s) shown on the plans and shall be constructed as shown on the plans in accordance with Item 303. Portland Cement Concrete Paving.