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## 401 INTRODUCTION

This Section shall govern the replacement, rehabilitation, or new construction of roadways, including items such as structures, signage, and other items not applicable to other sections.

## 402 SUBGRADE PREPARATION

### 402.1 DESCRIPTION

Subgrade is that portion of the roadbed upon which the subbase, base or the pavement is to be placed. It includes 12-in. beyond the back of the curb for streets, which are to be paved with concrete.

This item shall consist of scarifying, blading and rolling the subgrade to obtain a uniform texture and provide as nearly as practicable a uniform density for the top 6-in of the subgrade, or other depths as may be called out in the plans or the bid form. These specifications shall govern for the preparation of the subgrade except as otherwise provided or specified.

### 402.2 EQUIPMENT

All equipment necessary for the construction of this item shall be on the project and shall be approved by the OWNER 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. Compaction equipment shall conform to the requirements of Item for Proof Rolling.

In lieu of the subgrade equipment specified, the CONTRACTOR may, upon written permission from the OWNER, operate other subgrade equipment that will produce equivalent results in the same period of time as the specified equipment. If the substituted subgrade equipment fails to produce the desired results within the same period of time as would be expected of the specified equipment, as determined by the OWNER, its use shall be discontinued.

### 402.3 CONSTRUCTION METHODS

After the excavation of embankment has been substantially completed, the subgrade shall be shaped so that after rolling as specified in Item for Proof Rolling 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 OWNER. All preparing of the right of way and/or clearing and grubbing and removal of concrete curbs, all organics (i.e., roots, trees, grass, and other humus materials) and any other deleterious materials, shall be complete before starting the subgrade preparation. All unsuitable material shall be removed and replaced with approved material. All foundations, walls or other objectionable material shall be removed to a minimum depth of 18 inches under all structures and 12 inches under areas to be vegetated. Subgrade shall be scarified at least 6 inches of the cut soil subgrade, and re-compacted to standard as shown below.

In the event that fill material is required to be placed over the subgrade to achieve required grades, approved material shall be placed in 8-inch loose lifts and compacted and tested in accordance with Section for Embankment requirements.

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 10-ft. measured longitudinally shall be corrected by loosening, adding or removing material; reshaping; and re-compacting by sprinkling and rolling. The completed subgrade shall have a uniform density of not less than 95-percent Standard Proctor density (ASTM D 698). Density tests shall also be performed on any utility trench backfill

beneath the proposed roadway to verify that adequate compaction levels have been achieved. Moisture content shall be within -2 to +4 of optimum.

The Contractor will be required to set blue tops for the subgrade and any required fill material on centerline, at quarter points and curb lines or crown lines at intervals not exceeding 50 feet. Subgrade shall be prepared and tested at a rate of one test per 500 feet per lane prior to placement of embankment or select fill material.

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. 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 OWNER 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.

#### **402.4 MEASUREMENT AND PAYMENT**

Unless otherwise noted in the contract documents the preparation of subgrade shall not be measured for payment as a separate contract pay item. This item shall be considered subsidiary to other paving items. Item shall furnish of all labor, tools, materials, equipment and incidentals necessary to complete the work, including disposal or surplus material, all in accordance with the plans and these specifications.

If required the preparation of subgrade shall be measured by the square yard (SY) regardless of the required depth of preparation; and cost thereof shall be included in such contract items as are provided, which pay items shall be the total compensation for the furnishing of all labor, tools, materials, equipment and incidentals necessary to complete the work, including disposal or surplus material, all in accordance with the plans and these specifications.

### **403 FLEXIBLE BASE OR SUBBASE PREPARATION**

#### **403.1 DESCRIPTION**

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, flexible base or subbase includes 12-in. beyond the back of the curb for streets, which are to be paved with concrete.

This item shall consist of scarifying, blading and rolling the subgrade to obtain a uniform texture and provide as nearly as practicable a uniform density for a minimum of 6-inches, or other depths as may be called out in the plans or the bid form. The base layer shall be constructed as herein specified in one course for depths less than 6" and two courses for depths greater than 6", in conformity with the typical sections and to the lines and grades as indicated or as established by the OWNER.

These specifications shall govern for the preparation of the subbase except as otherwise provided or specified. 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 OWNER.

#### **403.2 EQUIPMENT**

All equipment necessary for the construction of this item shall be on the project and shall be approved by the OWNER 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.

In lieu of the subgrade equipment specified, the CONTRACTOR may, upon written permission from the OWNER, operate other subgrade equipment that will produce equivalent results in the same period of time as the specified equipment. If the substituted subgrade equipment fails to produce the desired results within the same period of time as would be expected of the specified equipment, as determined by the OWNER, its use shall be discontinued.

### 403.3 MATERIALS

The flexible base delivered shall be free of all foreign material or debris (i.e. reinforcement steel, dirt, plastic, trash). Material shall consist of durable particles of crushed limestone or crushed concrete and shall be free of thin, laminated, or elongated pieces, or an excess of shale, dirt, organic matter or other materials that would be harmful to the production of a homogenous base coarse. Should the CONTRACTOR elect to produce the material from local pits, the material shall be secured from sources approved by the OWNER. 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 the 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.

Aggregate that fails to meet the requirements of these specifications may be rejected by the OWNER. Such rejection shall incur no cost to the OWNER. Aggregate sources from which materials are delivered with properties not meeting these specifications may be rejected as further supply sources to the project by the OWNER.

#### 403.3.A. Testing

Tests base materials shall be in accordance with the following TxDOT standard laboratory test procedures:

- |  |                     |
|--|---------------------|
| 1. Preparation for Soil Constants and Sieve Analysis | Tex-101-E           |
| 2. Liquid Limit                                      | Tex-104-E           |
| 3. Plastic Limit                                     | Tex-105-E           |
| 4. Plasticity Index                                  | Tex-106-E           |
| 5. Sieve Analysis                                    | Tex-110-E           |
| 6. Wet Ball Mill                                     | Tex-116-E           |
| 7. Triaxial Test                                     | Tex-117-E (Part II) |

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.

Base material will be stockpiled after crushing, tested by the testing agency designated by the Owner and reviewed by the Owner prior to being hauled to the project site.

#### 403.3.B. Gradation

Gradation shall meet the requirements in Table 403.3.B.1 Flexible Base or Subbase Gradation, according to specified grade and properties according to Table 403.3.B.2.

**Table 403.3.B.1 Flexible Base or Subbase Gradation**

<b>Sieve Size</b>	<b>Percent Retained</b>
2 ½ inch	0
1¾ inch	0-10
No. 4	45-75
No. 40	60-85

**Table 403.3.B.2 Physical Properties**

<b>Physical Property</b>	<b>Max. Percentage</b>
Liquid Limit (LL)	35
Plasticity Index (PI)	4 - 12
Wet Ball Mill	50
Increase in passing No. 40 sieve	20

\* Tests shall be made in accordance with A.S.T.M. latest methods and Texas State Highway Department testing. Minimum compressive strength when subjected to the triaxial test: 35 psi at 0 psi lateral pressure and 175 psi at 15 psi lateral pressure, unless otherwise indicated.

### 403.3.C. Material Storage

Prior to stockpiling of aggregates, the area shall be cleaned of trash, weeds and grass and be relatively smooth. Stockpiles should be constructed to between 20,000 and 40,000 cubic yards in size. The size should be limited to the ability of the available equipment to construct, mix and test the pile. The stockpile shall be constructed utilizing equipment such as a scraper, a bottom dump or other acceptable equipment that allows spreading when dumped without re-handling. The stockpile shall be constructed to allow dump spreading in 1 direction only. Height of stockpile shall not exceed the capabilities of available machinery to make a full cut (bottom to top) on any of the 4 sides.

The Contractor will furnish tests on a completed stockpile. Tests shall be performed by a qualified provider of material testing services. The stockpile shall not be added to after it has been tested.

## 403.4 CONSTRUCTION METHODS

After the excavation of embankment has been substantially completed and the subgrade operations have been completed per specifications set forth herein, the subbase and/or base layer shall be shaped and shall conform to the correct alignment, cross section and elevation.

### 403.4.A. Placing

Immediately before placing the subbase or base course material, the subgrade shall be checked as to conformity with grade and section. A minimum of 2 inches of depth of the existing base material shall be uniformly scarified and mixed with the first course of base prior to compaction.

The material shall be delivered in 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 OWNER. 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 OWNER. 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 for 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 OWNER 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 1/4-in. in cross section in a length of 16-ft. measured longitudinally shall be corrected by loosening, adding or removing material, reshaping and re-compacting 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 re-compacting 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 re-compacted and refinished at the sole expense of the CONTRACTOR.

#### **403.4.B. 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. in thickness, it shall be constructed in two or more courses of equal thickness as indicated on the typical section. Course depth shall be a minimum of 3-in. and maximum of 6-in. 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 for Concrete Curb and Gutter.

In addition to the requirements specified for density, the full depth of flexible base shall be compacted to the extent necessary to remain firm and stable under construction equipment. After each section of flexible base is completed, tests as necessary will be made by the Contractor. If the material fails to meet the density requirements, it shall be reworked as necessary to meet these requirements. Should the base course, due to any reason or cause, lose the required stability, density and finish before the surfacing is complete, it shall be re-compacted and refinished at the sole expense of the Contractor.

#### **403.4.C. Density**

Each course of flexible base shall be compacted to not less than 95 percent of optimum density, as determined by TxDOT test method Tex-114, in accordance with ASTM D2167 Nuclear Test Method. In no case shall the base be worked at more than 2 percent above or below optimum moisture. Field density determinations shall be made in accordance with approved methods. Tests shall be performed at intervals not exceeding 500 feet at random points on the roadway cross section.

### **403.5 MEASUREMENT AND PAYMENT**

Preparation of base and subbase shall be measured by the square yard (SY) regardless of the required depth of preparation.

1. For flexible base paid as measured in place, the quantity shall be computed by the average end area method based on cross sections taken before beginning of any construction operations, and equivalent cross sections taken after completion and acceptance of the flexible base. The contractor shall be required to provide cross sections of the existing topography before beginning of any construction operations, and shall be required to provide cross sections immediately following completion and acceptance of the flexible base. The manner, location, and level of detail of the cross sections shall be as approved by the OWNER. The contractor shall calculate the total flexible base volume and submit both sets of cross sections and the calculations to the OWNER for review and approval.

2. For flexible base paid as a plans quantity item, no field measurement shall be made, and payment shall be at the unit price bid for the quantity shown on the plans. No adjustment of quantities shall be made except in the instance of design changes by the OWNER.
3. Where no curb and gutter is in place or is to be constructed in connection with the base, measurement shall be made to the lines shown on the plans or established as the edge of the base to be constructed.
4. Where curb and gutter is in place or is proposed to be constructed in connection with the placing of the base material, measurement shall be made to 12-in beyond the back of curb. Material placed under the curb and gutter or behind the curb shall not be measured separately but in conjunction with the rest of the roadway base material.

Preparation of the base and/or subbase shall be paid for as a separate contract pay item; and cost thereof shall be included in such contract items as are provided, which pay items shall be the total compensation for the furnishing of all labor, tools, materials, equipment and incidentals necessary to complete the work, including disposal or surplus material, all in accordance with the plans and these specifications. Price shall be full compensation for preparation of subgrade, furnishing of material, hauling, blading, sprinkling, compacting and furnishing all of labor and equipment necessary to complete the work.

#### 404 ROLLING OF EMBANKMENT, SUBGRADE OR FLEXIBLE BASE

##### 404.1 DESCRIPTION

Rolling shall consist of the compaction of embankment, subgrade, subbase, or flexible base by the operation of approved power rollers, as herein specified and as directed by the OWNER. The embankment, subgrade or base course shall be sprinkled as directed by the OWNER. Rolling patterns and speeds shall be established per project and indicated on the plans. Any soft or compressible areas detected during the proof rolling process shall be undercut to firm soil and backfilled as required by the OWNER with acceptable soil to make the final grade.

##### 404.2 EQUIPMENT

All equipment necessary for the construction of this item shall be on the project and shall be approved by the OWNER 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. Sufficient rollers shall be provided to compact the material in a manner satisfactory to the OWNER. 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.

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 OWNER, at no additional cost to the OWNER.

In lieu of the equipment specified, the CONTRACTOR may, upon written permission from the OWNER, operate other compaction equipment that will produce equivalent results in the same period of time as the specified equipment. If the substituted equipment fails to produce the desired results within the same period of time as would be expected of the specified equipment, as determined by the OWNER, its use shall be discontinued.

##### 404.3 MEASUREMENT AND PAYMENT

This item shall be considered subsidiary to other paving items; and shall be the total compensation for all labor, materials, tools, machinery, equipment and incidentals necessary to complete the work in accordance with the plans and this specification.

If included in the contract documents as a separate contract pay item, rolling shall be measured for payment by the actual hours the roller is in operation (Hrs), as ordered by the OWNER. Rolling provided in the proposal and the contract, as a separate pay item, shall be paid for in accordance with the contract unit price.

**405 PAVEMENT SECTION TREATMENT**

This item shall consist of treating embankment, subgrade, subbase, and base courses by addition of lime, cement, or asphalt; mixing and compacting the material to the required density.

**405.1 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.

**405.1.A. Materials**

Materials for Lime Treatment shall consist of Hydrated Lime (Slurry) and Quicklime.

**405.1.A.1. Hydrated Lime (Slurry):** 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.

**405.1.A.1.a. Gradation:** The "solids content" of the lime slurry shall have a hydrate alkalinity  $Ca(OH)_2$  of not less than 90-percent by weight. The percent by weight of residue retained in the "solid content" of lime slurry shall conform to the requirements in Table 405.1.A.1.a.(1) Hydrated Lime Residue.

**Table 405.1.A.1.a.(1) Hydrated Lime Residue**

Sieve Size	Residue Retained by Weight
No. 6	None
No. 10	Max.1.0%
No. 30	Max. 2.5%

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

**Grade 1:** The "dry solids contents" shall be at least 31-percent by weight of the slurry.

**Grade 2:** The "dry solids contents" shall be at least 35-percent by weight of the slurry.

**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 OWNER in writing before changing from one grade to another.

**405.1.A.2. Quicklime:** 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.

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

Quicklime shall conform to the chemical requirements of ASTM C977 Quicklime and Hydrated Lime for Soil Stabilization. Water shall conform to the requirements of section for Water under Item for Portland Cement Concrete Pavement.

**405.1.A.3. Testing:** If the minimum design strength or percent lime to be used is specified, it shall be determined by preliminary laboratory tests at the OWNER'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 06276 Test Method for using pH to Estimate the Soil-Lime Proportion Requirement for Soil Stabilization (pH Soil-Lime Series).

**405.1.A.4. 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; 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 OWNER.

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.

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

#### 405.1.B. Equipment

Machinery, tools and equipment necessary for proper performance of the work shall be on the project and approved by the OWNER prior to the beginning of construction operations. When permitted, quicklime shall be slurred 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.

#### 405.1.C. Construction Methods

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 OWNER.

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

Mixing procedure shall be the same for "dry placing" or "slurry placing" as hereinafter described.

**405.1.C.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.

**405.1.C.1.a. Mixing:** Mixing procedure shall be the same for "dry placing" or "slurry placing" as hereinafter described.

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 OWNER. 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 non-slaking aggregates obtained on the No. 4 sieve are removed, the remainder of the material shall meet the requirements of Table 405.1.C.4.a.(1) Mixing Lime Treated Materials-In-Place when tested dry by laboratory sieves.

**Table 405.1.C.4.a.(1) Mixing Lime Treated Materials In Place**

<b>Sieve Size</b>	<b>Minimum Passing</b>
1¾-in	100%
No. 4	60%

1. Recycled asphalt pavement shall be pulverized so that 100% shall pass a 2-in. 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 OWNER. After curing, mixing shall continue until the pulverization requirements are met.

**405.1.C.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.

**405.1.C.2.a. Mixing:** Mixing procedure shall be the same for "dry placing" or "slurry placing" as hereinafter described. 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 OWNER.

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.

**405.1.C.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 OWNER.

**405.1.C.3.a. Dry Placing:** Quicklime may be placed dry if it is in pebble form. A spreader or motor grader shall be used to spread pebble Quicklime.

**405.1.C.3.b. Hydrated Lime:** 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.

**405.1.C.3.c. Quicklime:** When Quicklime is applied as a slurry, the amount of dry quicklime shall be 80% of the amount shown on the plans. The residue from the Quicklime slurring procedure shall be spread uniformly over the length of the roadway currently being processed unless otherwise approved by the OWNER. 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.

**405.1.C.4. Compaction:** Compaction of the mixture shall begin immediately after final mixing and in no case later than three (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 OWNER. The compacted mixture shall have a uniform density of not less than 98-percent of the maximum density as determined by ASTM D 698. Moisture content shall be within minus 2 to plus 4 percent of optimum. After each section is completed, such tests as are necessary shall be made by the OWNER. 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.

**405.1.C.5. 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 OWNER as to grade, crown, and cross section until such time as the surface course is constructed. Only lime treated soil shall be used for fine grading proposed street pavement subgrade where lime treatment has been specified. The subgrade of low areas shall be lightly scarified to a depth of from two to 3 inches before fine grading is performed to insure the resulting subgrade is a homogeneous, monolithic layer throughout. Use of sand or sandy soil for fine grading beneath proposed street pavement areas is strictly prohibited.

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 for Emulsions. 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, the exact rate to be determined by the OWNER. No equipment or traffic shall be permitted on lime treated material for 72-hours after curing seal is applied, unless otherwise permitted by the OWNER. 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 OWNER and in a manner to insure restoration of a uniform surface and durability of the portion repaired.

#### 405.1.D. Measurement and Payment

Lime treatment shall be measured for payment in square-yards (SY) for the thickness shown in the plans for the surface area of completed and accepted work.

The measurement for lime shall be by the ton (2000-pounds) of dry weight. The measured tonnage of (dry) quicklime shall be multiplied by the conversation factor 1.25 to give the equivalent quantity of hydrated lime (dry) which shall be the basis of payment.

Lime treatment shall be paid for at the contract unit price per square-yard (SY), as provided in the proposal and contract.

The contract unit price shall be the total compensation for preparing the roadbed; for loosening, pulverizing, application of lime, water content in the slurry mixture and the mixing water; mixing, shaping, sprinkling, compacting, finishing, curing and maintaining; for manipulations required; and for all labor, equipment, fuels, tools and incidentals necessary to complete the work, all in accordance with the plans and specifications.

Lime material measured as provided in the this item shall be paid for at the unit price bid for "lime material" which price shall be full compensation for furnishing the material; for all freight involved; for all unloading, storing and handling; and for all labor, equipment, fuels, tools and incidentals necessary to complete the work.

#### **405.2 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 OWNER. 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.

##### **405.2.A. Materials**

Materials for Portland Cement Treatment involve Portland Cement, Water, and Soil or Base Material. All cement shall be sampled and tested in accordance with the current Standard Methods of Sampling and Testing Portland Cement of the ASTM Designation C-183, C-184, C-188, C-190 and C-191.

1. Cement shall be ASTM C150 Type I, II, III, or IP and conform to the requirements of Item for Portland Cement Pavement.
2. Water shall conform to the requirements of Item for Portland Cement Pavement.
3. 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 OWNER, or a combination of existing and additional soil from approved sources, as shown on the plans, or as directed by the OWNER.
4. Base Material shall conform to the requirements of Item for Flexible Base or Subbase Preparation.

Portland Cement shall meet the requirements of the current Standard Specifications for Portland Cement of the ASTM Designation C-150, Type I, for Normal Portland Cement, Type III for High Early Strength Portland Cement and Type II will have a maximum of five (5) percent tricalcium aluminate for exposure to sewage.

##### **405.2.B. 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 OWNER 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, incorporating 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.

##### **405.2.C. Construction Methods**

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 and falling, but may be mixed or placed with the air temperature is above 35°F 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 OWNER, are suitable.

**405.2.C.1. 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 405.2.C.1.a. Cement Treated Materials in Place.

**Table 405.2.C.1.a. Cement Treated Materials in Place**

<b>Sieve Size</b>	<b>Minimum Passing</b>
1-in	100%
No. 4	80%

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

**405.2.C.1.b. Application:** 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 OWNER. 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 or base material.

Any mixing 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.

**405.2.C.1.c. Compaction:** 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. At the start of compaction, the percentage of moisture in the mixture and in un-pulverized soil lumps, based on oven-dry weights, shall be within 2-percentage points of the specified optimum moisture content and shall be less than the quantity which shall cause the soil-cement mixture to become unstable during compaction and finishing. When the un-compacted 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 -2 to +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., 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 OWNER, 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.

OWNER shall conduct In-place density tests shall as outlined in ASTM D2922 in Place by Nuclear Methods (Shallow Depth). In-place density tests shall be performed at the rate of one-per-300-linear-ft. of paving for two lanes. The suitability of the modification shall be confirmed by Atterberg Limit testing at the rate of one-test-per-2,500-cubic-yards 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 OWNER. 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 re-compacted and refinished at the sole expense of the CONTRACTOR.

**405.2.C.2. Plant Mixed Material:** Cement Treated Base (CTB) shall consist of aggregate, cement and water uniformly mixed in a central plant, transported to the project, spread, compacted, shaped, finished, and cured in accordance with these specifications. It shall conform to the lines, grades, 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.

**405.2.C.2.a. Mixing:** The aggregate, cement and water shall be mixed in a pug mill as approved by the OWNER. 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 OWNER for construction quality control. The mixture shall be hauled to the paving area in trucks having beds cleaned of deleterious material.

**405.2.C.2.a.(1) Aggregate:** The aggregate may be any granular material or combinations of aggregates that will, when mixed with adequate amounts of cement and water, produce laboratory mix design Unconfined Compression Test strengths as specified in the paragraph below in accordance with ASTM D1632. The preceding tests will utilize the Moisture-Density Relation as determined by ASTM D558: AASHTO T134. The maximum size of aggregate shall pass a 2-inch sieve.

**405.2.C.2.a.(2) Mix Design:** The CONTRACTOR shall submit a mix design for the proposed CTB to the OWNER for approval in advance of the proposed work. Unconfined compression strength test results shall be submitted with the mix design by the SUPPLIER of the Cement Treated Base (CTB) material. Work shall not begin until the mix design is approved by the OWNER.

**405.2.C.2.b. Placement:** 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 OWNER 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.

**405.2.C.2.c. Compaction:** At the start of compaction, the percentage of moisture in the mixture shall not be more than 1% below or 2% 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, 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.

**405.2.C.3. Finishing:** After the final layer or course of the cement modified soil 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.

**405.2.C.3.a. 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. The curing seal shall consist of emulsified asphalt conforming to requirements of Item for Emulsions (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 soil-cement 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, it 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.

**405.2.C.3.b. Usage:** 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.

**405.2.C.3.b. 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., 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.

#### 405.2.D. Measurement and Payment

Portland cement treatment shall be measured by the square-yard (SY) of completed and accepted cement treated course. Measurement for cement shall be by the ton (2000-pounds) of dry weight, as determined by certified weight tickets. No allowance shall be made for any materials used or work done outside the limits as established by the OWNER.

The work performed and material furnished as prescribed by this item and measured as provided in this item shall be paid for at the unit price bid for soil-cement treated subgrade, subbase, or base course, which price shall be full compensation for pulverizing or providing the soil material; handling, hauling and spreading dry or slurry cement, mixing the cement with the soil either in-place or in a mixing plant; furnishing, hauling and mixing water with the soil-cement mixture; spreading and shaping the mixture; compacting the mixture, including all rolling required for this compaction; surface finishing; curing; and for all manipulation, labor, equipment, appliances, tools and incidentals necessary to complete the work and carry out the maintenance provisions in this specification.

Cement material measured as provided in this item shall be paid for at the unit price bid for cement material, which price shall be compensation for furnishing the material, for all freight involved, for all unloading and storing, and for all labor, equipment, fuels, tools and incidentals necessary to complete the work, all in accordance with the plans and these specifications.

### 406 ASPHALT PAVEMENT

This Item establishes the requirements for asphalt construction. This item shall consist of a surface course to be composed of a compacted mixture of mineral aggregate and asphaltic material. The pavement shall be constructed on the previously completed and approved base in accordance with the detail indicated.

#### 406.1 HOT MIX ASPHALT (HMAC)

This item shall consist of a surface course to be composed of a compacted mixture of mineral aggregate and asphaltic material. The pavement shall be constructed on the previously completed and approved base in accordance with the detail indicated.

##### 406.1.A. Materials

The Contractor shall furnish materials to the project meeting the following requirements and such that the final mixture, prior to being placed, shall be as specified herein. The Contractor shall be solely responsible for the quality and control of his materials.

**406.1.A. Aggregates:** Aggregates for Surface Treatments shall be provided in accordance with TxDOT Item 302 in conformance to the type, grade, and surface aggregate classification (SAC) shown on the plans.

**406.1.B.1. Asphalts, Oils, and Emulsions:** Asphaltic Material shall be provided in accordance with TxDOT Item 300 and as shown on the plans.

**406.1.B.1.a Prime Coat:** If a prime coat is indicated use cutback (MC-30 or MC-70) or emulsion asphalt. Cutback asphalt shall be applied at a rate of 0.35 gal/sy, and emulsified asphalts shall be applied at a rate of 0.2 gal/sy conforming to materials and methods of TxDOT Item 310 "Prime Coat".

**406.1.C.1. Mixtures:** Mixture Design shall be performed in accordance with TxDOT Item 340 to satisfy Materials and Type specified on the plans.

The paving mixture shall consist of a uniform mixture of coarse aggregate, fine aggregate, asphaltic material and mineral filler, if required. When properly proportioned, the mineral aggregate shall produce a gradation which will conform to the limitations for the type specified. The gradation will be determined in accordance with TxDOT Test Method Tex-200-F (Dry Sieve Analysis) and shall be based on aggregate only. The amount of asphaltic material shall conform to the limitations shown for the paving type specified and materials and mixture design specified in TxDOT Item 340.

#### 406.1.B. Construction Methods

Design, produce, store, transport, place, and compact the specified paving mixture in accordance with the requirements of TxDOT Item 340.

**406.1.B.1. Testing:** The OWNER may require the performance of random tests to determine if the materials and the construction procedures produce a product which meets the specifications. The primary sampling point by the testing laboratory will be at the project site at the paving machine ahead of all rollers. Other testing may be at the job site, plant or in the trucks as determined by the OWNER.

The OWNER will determine the sampling schedules for random testing. Gradation and stability samples will be taken at the plant or on the project site as determined by the OWNER. A minimum of 3 samples may be obtained for each project. Field density shall be determined by taking either 6 inch cores or sections of asphaltic pavement at locations selected by the OWNER of completed asphaltic pavement lifts for approximately every 2,000 square yards or part thereof. Acceptability will be based on the mean of the job values.

Any sampling and testing, as required by the OWNER or OWNER, of in place asphalt concrete will be at the cost of the Contractor.

**406.1.B.1.a. Surface Tests:** The surface of the pavement, after compaction, shall be smooth and true to the established line, grade and cross section, and when tested with a 10 foot straightedge placed parallel to the centerline of the roadway or tested by other equivalent and acceptable means, except as provided herein, the maximum deviation shall not exceed 1/8 inch in 10 feet and any point in the surface not meeting this requirement shall be corrected. The completed surface shall meet the approval of the OWNER for riding surface, finish and appearance.

**406.1.B.2. Compaction:** The mix shall be thoroughly compressed and uniformly compacted immediately after placing to the required density. All vibratory and flat wheel compaction rolling shall be complete before the mat cools below 175° F. Pneumatic tire rolling may be undertaken on the mat below 175° F.

All rollers must be in good mechanical condition. Necessary precautions shall be taken to prevent the dropping of gasoline, oil, grease or other foreign matter on the pavement, either when the rollers are in operation or when standing.

It is the intent of this specification that the material be placed and compacted to between 91 and 95 percent of the maximum theoretical density as determined by TxDOT Tex-227-F. The OWNER may secure 6 inch core

samples or sections of completed asphaltic pavements lifts for approximately every 2,000 square yards or part thereof, of asphaltic concrete pavement placed. The in place density at the sampled locations shall be determined by the following equation:

$$\text{Percent in place Density} = (GA \times 100)/GT$$

Where GA = Bulk specific gravity of core when tested in accordance with Tex-207-F

GT = Maximum theoretical specific gravity of combined cores when tested in accordance with Tex-277-F

The Contractor shall patch the surface where specimens are taken with no extra payment being made for this work. The OWNER may remove the asphaltic concrete pavement specimen on the day following placement or as soon as practicable thereafter. Other methods of determining in place density which correlate satisfactorily with those results obtained by cores or sections may be used.

#### **406.1.C. Measurement and Payment**

Asphaltic concrete pavement will be measured by the square yard (SY) of the specified total thickness, or per Ton (2000-lbs), of the type actually used in the completed and accepted work in accordance with the plans and specifications.

The work performed and materials furnished as prescribed by this item and measured as provided under "Measurement and Payment" will be paid for at the unit prices bid or the pay adjusted unit price for "Hot Mix Asphaltic Concrete" of the type and lift specified, which prices shall be full compensation for furnishing all materials, freight involved; for all heating, mixing, hauling, cleaning the existing base course or pavement, saw cutting, placing asphaltic concrete mixture, rolling and finishing, for all manipulations, labor, tools, equipment, temporary pavement markings and incidentals necessary to complete the work. Correcting defective work and the subsequent retesting shall be considered subsidiary to Item for Asphalt Pavement.

The prime coat, or tack coat, when required, will not be measured or paid for directly but shall be considered subsidiary to Item for Asphalt Pavement.

All templates, straightedges, scales and other weighing and measuring devices necessary for the proper construction, measuring and checking of the work shall be furnished, operated and maintained by the Contractor at his expense.

When not included as a specific payment item, installation of all items under this section shall be subsidiary to other items in the contract. Payment, when included as a specific pay item, for work meeting the requirements of this section shall be made either per square yard (SY) or per Ton (2000 lbs) of material installed in place.

#### **406.2 TWO COURSE ASPHALT PAVEMENT**

This item shall consist of a wearing surface composed of one or more applications of asphaltic material, each covered with aggregate constructed on the prepared base course herein specified and in accordance with the Contract Documents.

##### **406.2.A. Description**

All specifications in this item shall be in conformance with the TxDOT Standard Specifications for Construction and Maintenance of Highways, Streets and Bridges 2004, herein referred to as TxDOT 2004 Highway Standards.

Two course surface treatment shall not be applied when the air temperature is below 60° F and is falling, but it may be applied when the air temperature is above 50°F and is rising. Air temperature shall be taken in the shade and away from artificial heat. Asphaltic material shall not be placed when general weather conditions, in the opinion of the OWNER, are not suitable.

**406.2.B. Materials**

**406.2.B.1. Aggregates:** Aggregates to be composed of sound and durable particles of gravel, crushed gravel, crushed stone, crushed slag, burned clay, burned shale or natural limestone rock asphalt. These materials shall contain no more than 1 percent (1%) by weight of organic matter (other than native bitumen), clays, loam or pebbles coated therewith and shall contain no more than 5 percent (5%) by weight of any one combination of slate, shale, or soft particles of sandstone when tested in accordance with Test Method TEX-217-F. The percent of wear on natural limestone rock asphalt aggregate as determined by Test Method TEX-410-A shall be made on that portion of the material retained on the #4 sieve, having naturally impregnated asphalt content of less than 1 percent (1%). When tested by Test Method TEX-200-F the percent by weight shall be as follows:

**Table 406.2.B.1.a. Gradation (Grade 4)**

Sieve Size	Percent Retained
5/8"	0
1/2"	0-5
3/8"	20-40
No. 4	95-100
No. 8	98-100

Application Rate - Min. 1 CY covers 90 SY, max. 1 CY covers 110 SY, 1-110.

**406.2.B.2. Asphalts, Oils, and Emulsions:** Unless specified otherwise on the Construction Plans, asphaltic materials shall be AC-5 Asphaltic Cement or EA-HVRS, Anionic Emulsion, as specified by TxDOT Item 300 of TxDOT 2004 Highway Standards. Application Temperature for AC-5 shall be between 275 -375°F and for EA-HVRS shall be between 110 - 150°F. Rate of Application shall be 0.35 - 0.45 gal. per square yard for the first course and 0.25 - 0.35 gal. per square yard for the second course.

If AC-5 Asphaltic Cement is used, it shall contain a Latex Additive as specified in the above mentioned TxDOT Item 300. The base shall be prime coated in accordance with TxDOT Item 310 at a rate of 0.10 gal. per square yard min. prior to application of the paving.

**406.2.C. Construction Methods**

**406.2.C.1. Chip Seal:** Chip Seal shall be installed as follows: the area to be treated shall be cleaned of dirt, dust, or other deleterious matter by sweeping or other approved methods. If it is found necessary by the OWNER, the surface shall be lightly sprinkled just prior to the first application of asphaltic material.

Asphaltic material, as specified above, shall be applied on the clean surface by an approved type of self-propelled pressure distributor so operated as to distribute the material in the quantity specified, evenly, smoothly, under a pressure necessary for proper distribution. The Contractor shall provide all necessary facilities for determining the temperature of the asphaltic material in all of the heating equipment and in the distributor, for determining the rate at which it is applied, and for securing uniformity at the junction of two distributor loads. The distributor shall have been recently calibrated and the OWNER shall be furnished an accurate and satisfactory record of such calibration. After beginning work, if the yield of the asphaltic material appears to be in error, the distributor shall be recalibrated in a manner satisfactory to the OWNER before proceeding with the work.

Asphaltic material for each course may be applied for the full width of the surface treatment in one application, unless the width exceeds twenty-six feet (26'). No traffic or hauling will be permitted over the freshly applied asphaltic material. Asphaltic material shall not be applied until immediate covering is assured.

Aggregate, of the type and grade shown on the plans for the first course, shall be immediately and uniformly applied and spread by an approved self-propelled continuous feed aggregate spreader, unless otherwise shown on the plans or authorized by the OWNER in writing. The aggregate shall be applied at the approximate rates

indicated on the plans and as directed by the OWNER. The Contractor shall be responsible for the maintenance of the surface of the first course until the second course is applied.

The entire surface shall then be broomed, bladed or raked as required by the OWNER and shall be thoroughly rolled with power rollers of the three-wheel or tandem, self-propelled type, weighing not less than 3 tons nor more than 6 tons. All wheels shall be flat.

In lieu of the rolling equipment specified, the Contractor may, upon written permission from the OWNER, operate the other compacting equipment that will produce equivalent relative compaction in the same period of time as the specified equipment. If the substituted compaction equipment fails to produce the desired compaction within the same period as would be expected of the specified equipment, as determined by the OWNER, its use shall be discontinued.

Rollers shall be maintained in good repair and operating condition and shall be approved by the OWNER.

**406.2.C.2. Two Course Surface Treatment:** Two Course Surface Treatment shall consist of an initial installation of Chip Seal as detailed in the preceding paragraph, followed by installation of a second course as follows: the second course shall consist of asphaltic material and aggregate of the type and grade indicated on the plans for the second course. The asphaltic material and aggregate for this second course shall be applied and covered in the manner specified for the first application. The surface shall then be broomed, bladed or raked as required by the Engineer, and thoroughly rolled as specified for the first course. Asphaltic materials and aggregates for both courses shall be applied at the approximate rates indicated on the plans and as directed by the Engineer.

The Contractor shall be responsible for the maintenance of the surface until the work is accepted by the Engineer and regulatory agency. The Contractor shall be responsible for the proper preparation of all stockpile areas before aggregates are placed thereon, including leveling of the aggregate to prevent any contamination thereof.

All storage tanks, piping, retorts, booster tanks and distributors used in storing or handling asphaltic materials shall be kept clean and in good operating condition at all times and they shall be operated in such manner that there will 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 Engineer will select the temperature of application based on the temperature-viscosity relationship that will permit application of the asphalt within the limits recommended in TxDOT Item 300, "Asphalts, Oils, Emulsions." The recommended range for the viscosity of the asphalt is 50 seconds to 60 seconds, Saybolt Furol. The Contractor shall apply the asphalt at a temperature within 15°F of the temperature selected.

#### **406.2.D. Measurement and Payment**

All acceptable Chip Seal or Two Course Surface Treatment will be measured by the square yard (SY) for completed and accepted work in accordance with the plans and specifications.

The work performed and materials furnished as prescribed by this item will be paid for at the unit price bid or the pay adjusted unit price for "Chip Seal" or "Two Course Surface Treatment" of the type and lift specified, which prices shall be full compensation for furnishing all materials, freight involved; for all heating, mixing, hauling, cleaning the existing base course or pavement, saw cutting, placing asphaltic concrete mixture, rolling and finishing; for all manipulations, labor, tools equipment, temporary pavement markings and incidentals necessary to complete the work. Correction of defective work and the subsequent retesting shall be included at CONTRACTORS expense; no separate pay item shall be provided.

The prime coat, when required, will not be measured or paid for directly but shall be considered subsidiary to this Section.

All templates, straightedges, scales and other weighing and measuring devices necessary for the proper construction, measuring and checking of the work shall be furnished, operated and maintained by the Contractor at his expense.

#### 407 CONCRETE PAVEMENT

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 OWNER. Concrete shall be considered of satisfactory quality and made of materials acceptable to the job and these specifications, in the proportions approved by the OWNER; and mixed, placed, finished and cured in accordance with the requirements of these specifications and any special provisions.

##### 407.1 MATERIALS

Concrete shall be composed of Normal Portland Cement or High Early Strength Cement, coarse aggregate, fine aggregate and water proportioned and mixed as hereinafter provided in these specifications.

##### 407.1.A. Aggregates

Aggregates for Portland cement concrete shall conform to the requirements contained in this Item and shall be approved by the OWNER 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.

**407.1.A.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.

**407.1.A.2. Measurement:** Fine and coarse aggregates shall be measured loose and separately. Aggregate weighing equipment shall conform to the requirements of ASTM C94 Standard Specification for Ready-Mixed Concrete and shall be approved by the OWNER prior to use.

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 OWNER 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.

**407.1.A.3. Testing:** All fine and coarse aggregates testing shall be done per TxDOT Item 360 "Concrete Pavement."



**407.1.A.4. Gradation:** The fine aggregate shall be well graded from fine to coarse and shall meet the requirements of Table 407.1.A.4.a. Fine Aggregates Gradation Requirements. Fine aggregate shall consist of natural sand, manufactured sand, or a combination thereof, conforming to the current ASTM Specification C-33. Stone dust or crushed sand may be added as mineral filler, if so directed by the OWNER. 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. 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 407.1.A.4.a. Fine Aggregates Gradation Requirements**

Sieve Size	Percent Retained
3/8"	0
No. 4	0-5
No. 8	0-20
No. 16	15-30
No. 30	35-75
No. 50	70-90
No. 100	90-100
No. 200	97-100

When subjected to the color test for organic impurities, TxDOT Test Method Tex-408-A, the fine aggregate shall not show a color darker than standard.

Coarse aggregate shall consist of gravel or crushed stone meeting the requirements of the current ASTM Specifications C-33. Coarse aggregate shall consist of durable particles of gravel, crushed blast furnace slag and/or crushed stone of reasonably uniform quality throughout, free from injurious amounts of salt, alkali, vegetable matter or other objectionable material, either free or as an adherent coating on the aggregate. It shall not contain more than 0.25 percent by weight of clay lumps nor more than 1.0 percent by weight of shale nor more than 5.0 percent by weight of laminated and/or friable particles when tested in accordance with TxDOT Test Method Tex-413-A.

Coarse aggregate shall have a wear of not more than 45 percent when tested according to TxDOT Test Method Tex-410-A and when tested by standard laboratory methods shall meet the requirements of Table 407.1.A.4.b. Coarse Aggregates Gradation Requirements.

**Table 407.1.A.4.b. Coarse Aggregates Gradation Requirements**

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

1. Corresponding ASTM C 33 gradation shown in parentheses.

Loss by Decantation per TxDOT Test Method Tex-406-A. 1.0% Maximum. In the case of aggregate made primarily from crushing of stone. If the material finer than the 200 sieve is definitely established to be the dust

of fracture essentially free from clay or shale as established by Part III of TxDOT Test Method Tex-406-A, the percent may be increased to 1.5.

Aggregates which fail to meet the requirements of these specifications may be rejected by the OWNER. Such rejection shall incur no cost to the OWNER. 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 OWNER. Such rejection shall incur no cost to the OWNER.

#### **407.1.B. Portland Cement**

Portland cement shall be in accordance with Item 405.2 for Portland Cement Treatment. Only one brand of cement shall be used in any one (1) structure, except by written permission of the Engineer. When such permission is granted and more than one (1) brand is used in one (1) structure, the resulting concrete shall be uniform in color.

#### **407.1.C. 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 OWNER and in accordance with the manufacturer's recommendations.

**407.1.C.1. Chemical Admixtures:** Chemical admixtures shall conform to ASTM C494 Chemical Admixtures for Concrete, Types "A", "D," "F" and "G" for concrete dosages in accordance with manufacturers' recommendations as specified by the OWNER.

Water-reducing admixtures conforming to ASTM C494, Types "A" and "F", shall be used to improve quality of concrete by obtaining specified strength at tower 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.

Air Entraining Admixture shall be used where specified or directed to improve workability and increase resistance to freeze and thawing, and scaling. The admixture shall comply with ASTM C 260 and shall be used in accordance with manufacturer's recommendations. Products shall be Air-Tite by Gifford Hill; Daravair by W.R. Grace; MB-VR by Master Builders, or approved equal.

The total air content of the concrete shall be three percent to six (6) percent.

**407.1.C.2. 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.

**407.1.C.3. Fiber:** At the OWNER'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. Add steel or polypropylene fibers only when called for on the plans or approved by the Engineer.

**407.1.C.3.a. Polypropylene Fiber:** Ratio shall be 1.5 pounds of fiber per cubic yard of concrete. Acceptable Manufacturer: W. R. Grace Company, Fibermesh, or approved equal.

Physical Properties:

1. Material: Polypropylene.
2. Length: 3/4 inch.
3. Specific Gravity: 0.91.
4. Absorption: None.
5. Tensile Strength: 70-110 Ksi.
6. Modulus of Elasticity: 500 Ksi.
7. Melt Point: 140 degrees F (60 degrees C).
8. Flash Point: 932 degrees F (500 degrees C).
9. Density: 3.pounds/cubic yard.

**407.1.C.3.b. Steel Fiber:** Steel fiber shall comply with applicable provisions of ACI 544 and ASTM A820. Ratio shall be 50 to 200 pounds of fiber per cubic yard of concrete.

Physical Properties:

1. Material: Steel.
2. Aspect Ratio (for fiber lengths of 0.5 to 2.5 inch, length divided by diameter or equivalent diameter): 30:1 to 100:1.
3. Specific Gravity: 7.8.
4. Tensile Strength: 40-400 ksi.
5. Young's Modulus: 29,000 ksi.
6. Minimum Average Tensile Strength: 50,000 psi.
7. Bending Requirements: Withstand bending around 0.125-inch diameter mandrel to an angle of 90 degrees, at temperatures not less than 60 degrees F, without breaking.

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

#### 407.1.D. 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. Water used shall meet the requirements of ASTM C94

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. Water for use with cement may be rejected for failure to meet any of the requirements of this specification and replaced at CONTRACTORS expense.

#### 407.1.E. Formwork

Formwork shall be clean and in good condition, free from dents and rust, grease or other foreign material that tend to disfigure or discolor concrete in a gage and condition capable of supporting concrete and construction loads without significant distortion. Form Ties shall be metal or fiberglass of approved type with tie holes not larger than 7/8 inch in diameter. Wire ties will not be allowed.

**407.1.E.1. Lumber and Plywood:** Materials shall be seasoned and of good quality, free from loose or unsound knots, knot holes, twists, shakes, decay and other imperfections which would affect strength or impair the finished surface of concrete. Forms for bottoms of caps: At least 2-inch (nominal) lumber or 3/4-inch form plywood backed adequately to prevent misalignment and distortion. General use: Provide lumber of 1-inch nominal thickness or form plywood of approved thickness.

**407.1.E.2. Rubbed Finish Exposed Concrete:** Form or form-lining surfaces free of irregularities; plywood of 3/4-inch minimum thickness, preferably oiled at the mill.

**407.1.E.3. Chamfer Strips:** Materials shall be redwood, cypress or pine that will not split when nailed and which can be maintained to true line. Use mill-cut molding dressed on all faces.

**407.1.E.4. Metal Forms:** Clean and in good condition, free from dents and rust, grease or other foreign material that tend to disfigure or discolor concrete in a gage and condition capable of supporting concrete and construction loads without significant distortion. Countersink bolt and rivet heads on facing sides. Use only metal forms which present a smooth surface and which line up properly.

#### 407.1.F. Reinforcing

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.

**407.1.E.1. Steel Reinforcement:** Unless otherwise specified or designated on the plans, the metal for all bar reinforcement shall meet following:

All bar reinforcement shall be open hearth new billet steel of structural, intermediate, or hard grade. New billet steel shall conform to the requirements of the latest Standard Specification for Billet-Steel Concrete Reinforcement Bars, ASTM Designation A615, A767 or A775, grade 40 or grade 60.

Unless otherwise shown on the plans, all reinforcing bars shall be deformed bars. Twisted bars are not considered as deformed bars and will not be used. The form of deformed bars shall be such as to provide a net sectional area at all points equivalent to that of the plain round bars of equal nominal size.

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.

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.

Reinforcement may be rejected for failure to meet any of the requirements of this specification.

**407.1.E.2. Steel Wire:** At the OWNER'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- W4 x W4. Wire for fabric reinforcement shall be cold-drawn from rods hot rolled from open hearth billets. Wire shall conform to the requirements of the latest Standard Specification for Drawn Wire for Concrete Reinforcement, ASTM Designation A-185 or A884.

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.

Reinforcement may be rejected for failure to meet any of the requirements of this specification.

**407.1.E.3. Tie Wire:** Tie wire shall be per ASTM A82. Use 16½ gauge minimum for tie wire, unless otherwise indicated.

**407.1.E.4. 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 OWNER; 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.

**407.1.E.5. 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 for 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.

Load Transmission Devices for Expansion and Contraction Joints, when indicated, shall meet the requirements specified herein:

Smooth steel bar dowels, used when indicated, shall be of the size and type indicated and shall be open-hearth, basic oxygen or electric-furnace steel conforming to the properties specified for grade 60 in ASTM A-615. The free end of dowel bars shall be smooth and free of shearing burrs.

When indicated, one end of each dowel bar shall be encased in an approved cap. The dowel caps and dowel bars shall be held securely in place by bar ties as indicated on the drawings. Mechanical methods of implanting dowel bars in the plastic concrete may be used when approved by the Engineer or designated representative. Where required, dowel bars shall be coated with a plastic material meeting the requirements indicated. Where red lead and oil bar coating is indicated, the red lead may be of any standard commercial grade and the oil shall be clean and no lighter than Standard No. 30 SAE grade. Approved thinner and dryer may be added to the red lead, but the material upon application shall be of such consistency that will provide a uniform and heavy coating on the bar. Where asphalt bar coating is indicated, the material may be any standard grade of oil asphalt and shall be applied hot. Cutback asphalt will not be permitted for bar coating.

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 1/8"-in., and one end of the cap shall be rightly closed. The cap shall be installed to allow the bar to move not less than 1-1/4"-in. in either direction.

#### 407.1.G. Joints

Joint filler is the material placed in concrete pavement and concrete structures to allow for the expansion and contraction of the concrete. Visible joint material shall have the color gray. Pre-molded Expansion Joint Filler shall conform to the requirements of ASTM Designation D-994 or other as approved by City Engineer.

Grout shall be non-shrink and shall conform to ASTM C 1107, Packaged, Dry, Hydraulic Cement Grout (Non-shrink), Grade C. Grout shall be packaged with mixed ingredients requiring the addition of water only.

**407.1.G.1. Preformed Asphalt Board:** Preformed asphalt board formed from cane or other suitable fibers of a cellular nature securely bound together and uniformly impregnated with a suitable asphaltic binder and meeting the requirements of the Standard Specifications for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction, ASTM D 1751.

**407.1.G.2. Preformed Non-bituminous Fiber Material:** Preformed non-bituminous fiber material shall meet the requirements of the Standard Specifications for the Preformed Expansion Joint Filler for Concrete Paving and Structural Construction, ASTM D 1751, except that the requirements pertaining to bitumen content, density and water absorption shall be voided.

**407.1.G.3. Boards:** Boards obtained from Redwood timber, of sound heartwood, free from sapwood, knots, clustered birdseye, checks and splits. Occasional sound or hollow birdseye, when not in clusters, will be permitted provided the board is free from any other defects that will impair its usefulness as a joint filler.

**407.1.G.4. Backer Rod:** Backer Rod shall be expanded closed cell polyethylene foam compatible with sealant. No bond or reaction shall occur between rod and sealant. Backer Rod shall be of sufficient width to be in compression after placement and shall be used with joint sealer.

**407.1.G.5. Joint Sealer:** This material shall be a one-part low modulus silicone especially designed to cure at ambient temperatures by reacting with moisture in the air. The sealant material shall have the following properties:

**Table 407.1.G.5.a. Joint Sealer Supplied Properties**

<b>Description</b>	<b>Property</b>
Color	Gray
Flow, MIL-2-8802D Sec. 4.8.4	0.2 Max.
Working Time	10 min.
Tack-Free Time at 77 F±2 F Min. MIL-2-8802D Sec.4.8.7	60
Cure time, at 77 F	7-14 Days
Full Adhesion Time	14-21 Days
As Cured-after 7 days at 77 F (25 C) and 40% RH	90-100
No. 200	97-100

**Table 407.1.G.5.b. Joint Sealer Cured Properties**

<b>Description</b>	<b>Property</b>
Elongation	1200% Min.
Durometer Hardness, Shore A, ASTM D 2240	15 Min.
Joint movement capability	+100/50 Percent
Tensile Strength, elongation	100% Max.
Peal strength	25-psi (172-kPa)

Properties are As Cured-after 7 days at 77 F (25 C) and 40% RH

The joint sealer shall adhere to the sides of the concrete joint or crack and shall be an effective seal against infiltration of water and incompressible. A backer rod shall be required which will be compatible with the sealant. No bond or reaction shall occur between the rod and sealant. The sealant shall adhere to the sides of the concrete joint. It shall not crack or break when exposed to temperatures below 32°F (0°C).

Asphalt, Redwood board or other materials used shall extend the full depth of the concrete and shall be perpendicular to the exposed face. All joints shall be shaped to conform to the contour of the finished section in which they are installed. All material shall be a minimum of ½ inch thick or as indicated. Wood materials shall be anchored to the adjacent concrete to permanently hold them in place. Joint sealer shall be installed in accordance with the manufacturer's recommendations.

The material used for sidewalk expansion joints, shall conform to Item for Boards above, unless otherwise indicated.

The material used for curb and gutter expansion joints filler shall conform to any of the above, except when placed adjacent to concrete pavement, the joint material shall match the pavement joint material.

**407.1.H. Concrete Properties**

Concrete shall be composed of cementitious materials, fine aggregate, coarse aggregate, mineral filler and/or admixture if used and water, mixed in the proportions designated by the approved Mix Design and in the manner set forth in this specification. On the basis of job and laboratory investigations of the proposed materials, the Contractor will fix proportions by weight of water, coarse aggregate, fine aggregate, cementitious materials, admixture and mineral filler where required, in order to produce concrete of the specified strength and workability for the actual delivery time and site conditions to be encountered.

Concrete shall be proportioned- as detailed in the approved mix design. The total volume of materials in the concrete mixture shall be so regulated that the cement content per cubic yard of concrete shall not be less than the minimum specified for that class of concrete.

It shall be the responsibility of the Contractor to furnish the mix design, using a Coarse Aggregate Factor acceptable to the City, for the class of concrete specified. The mix shall be designed by a certified testing laboratory to conform with the requirements contained herein and in accordance with ASTM C1077. The Contractor shall perform, at his own expense, the work required to substantiate the design, and testing of concrete strength. Complete concrete design data shall be submitted to the Engineer for approval.

**407.1.H.1. Concrete Classes:** The concrete shall be uniform and workable and the minimum cement content, maximum water content, for the various classes of mixes shall conform to the following table The concrete mix will be designed with the intention of producing concrete which will have compressive or flexural strength equal to or greater than the following when using current ASTM Designation C-39 and C-293:

**Table 407.1.H.1.a. Concrete Classes**

<b>Class of Concrete<sup>1</sup></b>	<b>Min. Cementitious (lb/CY)</b>	<b>28 Day Min. Compressive Strength<sup>2</sup> (psi)</b>	<b>28 Day Min. Beam Strength<sup>2</sup> (psi)</b>	<b>Max. Water/ Cementitious Ratio</b>	<b>Max. Coarse Aggregate Size<sup>4</sup></b>
A <sup>5</sup>	470	3000	500	0.58	1 ½"
C	564	3600	600	0.53	1 ½"
P1 <sup>5</sup>	517	4000	N/A	0.49	1 ½"
P2	564	4500	N/A	0.45	1 ½"
M	As Directed by OWNER				

1. All exposed horizontal concrete shall have entrained - air.
2. Minimum Strength Required by OWNER [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

**407.1.H.2. Slump:** Slump requirements for pavement and related concrete shall be as specified in Table 407.1.H.2.a. 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 407.1.H.2.a. Slump Requirements**

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

#### 407.1.I. Submittals

The proposed methods, materials, installations, and other details in the submittals shall be modified as required to obtain the Engineer's approval before beginning of construction. Prior to beginning construction, for each class of concrete to be used, the Contractor shall submit to the Engineer for approval the following items:

1. A concrete mix design that has been prepared by a certified testing laboratory to conform to the requirements contained in this Section. The submittal shall address all mixing and handling requirements as specified in this section.
2. A forming plan showing the forms to be used, the types of ties and bracing to be used, any construction joints that are proposed, pour rates, and other critical data. The form design is the complete responsibility of the Contractor, and the Contractor shall be required to obtain professional engineering assistance at his sole expense where appropriate for proper design.
3. A reinforcing schedule showing the size, type, grade, lengths, installation details, proposed supports, ties, and any other pertinent information related to the proposed reinforcing and its installation.

#### 407.2 EQUIPMENT

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

##### 407.2.A. 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. 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. for a form 8-in. 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. 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. metal form sections shall be used in forming curves with a 250-ft., and larger radius. For curves with a radius of less than 250-ft., acceptable flexible metal forms, or wood forms, may be used upon approval by the OWNER.

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.

#### 407.2.B. Vibratory Equipment

All concrete placed as Machine Finish class concrete shall be consolidated by approved mechanical vibrators attached to the machine, operated ahead of the transverse finishing screen, and designed to vibrate the concrete internally. Unless otherwise shown on the plans, vibrators of the surface-pan type may also be used for full-depth placement provided that internal vibrators fixed to the machine are also used for vibrating the concrete internally. 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 manner as not to interfere with the transverse or longitudinal joints.

The internal-type vibrators shall be spaced at not more than 24-in. 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 spud-type 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 OWNER. 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.

#### 407.2.C. Miscellaneous Equipment

The CONTRACTOR shall furnish a broom of the push broom type not less than 18-in. in width with stiff bristles for the final surface finish of concrete base or as the OWNER 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.

**407.2.C.1. Transverse Finishing Machine:** The transverse finishing machine may be used for Machine Finish class concrete placement for pavement provided that internal vibrators fixed to the machine are also used for vibrating the concrete internally. The requirements for fixed internal vibrators given in part Item for

Vibratory Equipment, shall apply. 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 internally with internal-type vibrators as required in part Item for Vibratory Equipment.

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 OWNER, and the CONTRACTOR shall provide approved equipment.

**407.2.C.2. 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 for Transverse Finishing Machine shall be acceptable.

**407.2.C.3. Hauling Equipment:** Batch hauling equipment for the transportation of measured materials from the batching plant to the mixer shall be equipped with tight covers, which shall be used to prevent excessive evaporation of moisture or any loss of material.

If a central mixer is used, concrete may be transported to the point of delivery in truck agitators or non-agitating trucks.

If a truck mounted paving mixer is used, it may be used to transport the concrete after mixing is complete.

If non-agitator trucks are used they shall conform to the following requirements:

The bed of non-agitating hauling equipment shall be a smooth, mortar-tight, metal container. The hauling equipment shall be capable of delivering the concrete to the work site in a thoroughly mixed and uniform mass and capable of discharging the concrete at a satisfactory controlled rate without segregation. If in the opinion of the Engineer any appreciable segregation or accumulation of excess water and/or mortar occurs on the surface of the concrete, this may be cause for rejection and this method of transporting the concrete to the point of delivery shall be suspended as directed by the Engineer.

### 407.3 CONSTRUCTION METHODS

#### 407.3.A. Mix Design

The Contractor shall perform at the Contractor's own expense and be responsible for the design of the concrete mix. The mix design shall be prepared and sealed by a person qualified and experienced in such work. Establish proportions on the basis either of laboratory trial batches or of field experience with the materials to be employed.

When ice is used to lower the concrete temperature during hot weather, the addition of ice shall not exceed 50 percent of the total mix water weight.

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 OWNER 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 OWNER 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.

At least 10-days prior to the start of concrete paving operations, the CONTRACTOR shall submit to the OWNER 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 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 OWNER shall be sufficiently large to permit laboratory batching for the construction of test specimens to check the adequacy of the design. When the OWNER 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 OWNER in writing to the CONTRACTOR.

**407.3.A.1. Testing:** The Contractor shall prepare a minimum of four concrete test cylinders of each mix design, cure and test two each at the age of 7 and 28 days. From these preliminary tests the water-cement ratio required to produce concrete of the specified strength will be selected by the Contractor for approval by the Engineer or designated representative. The Contractor may at any time present in writing a suggested mix design and if the Engineer or designated representative concurs with the suggested design, the Contractor shall conduct trial batches necessary to determine its acceptability under these specification requirements.

The Contractor shall furnish and operate the mixer approved for use on this project unless the concrete is to be furnished from a transit mix (ready-mix) plant. For mixing the concrete to be used in making the preliminary test specimens, a minimum 1 cubic yard batch shall be mixed or a batch of sufficient size to afford proper mixing, whichever is the greater. In lieu of the above mixer and procedure, the Contractor may furnish a portable mixer of sufficient rated capacity to mix a minimum 3-sack batch; in which case, the batch mixed for the preliminary test not to be less than the rated capacity of the mixer furnished. A coating batch will be mixed prior to mixing for test cylinders.

Test beams or cylinders shall be required for each fifty (50) cubic yards or portion thereof, placed each day. The Engineer shall take test cylinders for compressive strength values on a random basis. The comparative results shall consist of the average of 2 cylinders each at 7 and 28 days for regular concrete, high early strength concrete and high range water reducing admixture concrete.

After the mix proportions and water-cement ratio required to produce concrete of the specified strength have been determined, placing of the concrete may be started. The strength of the concrete in the completed pavement will be determined by a minimum of four compressive strength test specimens made, cured with a minimum of two each tested at 7 and 28 days as provided in TxDOT Bulletin C-11. Modifications of the mix design may be requested by the Contractor on basis of conformity of the strength of these test specimens with the requirements and intent of this specification.

Changes in the water-cement ratio and the mix design, including an increase in cement factor if necessary, will be made when the average 7 day and/or 28 day compressive strength of the concrete, as indicated by the last 10 compressive strength values obtained from tests of cylinders made from concrete of the same water-cement ratio, departs from the desired minimum average strength by more than 4 percent.

Additional tests may be taken as determined by the concrete placement conditions or for adequately determining the strength of concrete where the early opening of the pavement to traffic is dependent upon concrete strength tests. No extra compensation will be allowed for materials and work involved in fulfilling these requirements.

**407.3.A.2. Batching and Mixing:** All batching and mixing of concrete materials shall conform to ACI 304-73 "Recommended Practice for Measuring, Mixing and Placing Concrete". All materials shall be measured separately and accurately and batches shall be uniform. The coarse and fine aggregate shall be measured or weighed, loose and separately.

When transit mix concrete is used, the delivery of concrete shall be continuous at regular and uniform intervals, without stoppages or interruptions. Transit mix concrete shall not be placed in the job after a period of forty-five (45) minutes after the cement has been placed in the mixer.

**407.3.A.3. Delivery:** The rate of delivery of transit mixed concrete shall be so arranged that a cold joint is not allowed to form between loads. Concrete shall be hauled in vehicles so constructed and operated to provide constant agitation during transportation. Concrete improperly mixed shall not be placed in the structure.

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 will insure the discharging of the mixed concrete without segregation.

The mixer drum shall be water-tight when closed and shall be equipped-with a locking device which will automatically prevent the discharging of the mixer prior to receiving the required number of revolutions.

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.

The entire quantity of mixing water shall be accurately measured and controlled. Each batch shall be mixed to the consistency as described in the approved mix design. 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.

**407.3.A.3. Consistency:** In general, the consistency of concrete mixtures shall be such that:

- a. The mortar will cling to the coarse aggregate.
- b. The aggregate will not segregate in the concrete when it is transported to the place of deposit.
- c. The concrete and mortar will show no free water when removed from the mixer.
- d. The surface of the finished concrete will be free from a surface film of "laitance".

Any concrete mix failing to meet the above outlined consistency requirements, although meeting the slump requirements will be considered unsatisfactory, and the mix shall be changed to correct such unsatisfactory conditions.

### 407.3.B. Placing Concrete

The Contractor shall give the Engineer at least twenty-four (24) hours advance notice that he intends to pour concrete in any unit of the structure. Prior to starting work the Contractor shall inform the Engineer as to the methods of construction and the amount and character of equipment he proposes to use, the adequacy of which shall be subject to the approval of the Engineer. The mixing of concrete and placing of same in the forms shall not be commenced until the Engineer has given his approval. No concrete shall be placed in any unit prior to completion of the form work and the placement of the reinforcing and other steel.

**407.3.B.1. Subgrade Preparation:** 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. Subgrade shall be prepared as indicated in Items 402, 403, 404, and 405. 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 for Subgrade 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 OWNER.

**407.3.B.2. Forms:** Facing of  $\frac{3}{4}$ " grade B plywood will be permitted for general use on the various portions of structures, if backed by a sufficient number of studs and wales. Forms shall be mortar tight, and of sufficient strength to prevent bulging between supports. Forms shall be maintained to the lines designated until the concrete is sufficiently hardened to permit form removal and until the minimum time for forms to remain in place has elapsed in accordance with ACI Standard 318-71 "Building Code Requirements for Reinforced Concrete (ACI318-71)". Where corners occur, suitable chamfer strips shall be placed at the angle of the forms to round off or level them. All forms shall be constructed so as to permit removal without injuring the concrete. At the time of placing concrete, the forms shall be clean and entirely free of all chips, dirt, sawdust, and other extraneous matter.

For thin wall sections and other locations where access to the bottom of the forms by other methods would be cumbersome and inadequate, clean-out opening shall be provided.

Only spreaders approved by the Engineer shall be used.

Form ties of an approved type shall be used to hold forms in place. Such ties shall be of a type especially designed for use in connection with concrete work, and they shall have provision to permit ease of removal of the metal as hereinafter specified. The use of metal form ties of types that are encased in paper or other materials to allow the removal of the complete tie, leaving a hole through the concrete structure, will not be permitted. Metal ties shall be held in place by devices attached to walls. Each device shall be capable of developing the strength of the tie.

All cavities produced by the removal of metal ties shall be carefully cleaned and completely filled with re-tempered sand cement mortar mixed in proportion of one to three, and the concrete shall be left smooth and even. 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.

When forms settle over 1/8-in. 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.

Forms shall be thoroughly cleaned after each use and well-oiled before reuse.

**407.3.B.3. Placing Reinforcing:** Reinforcing steel, welded wire mesh, tie bars, dowels, etc., 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.

Dowel bars shall be accurately installed in joint assemblies as indicated on the drawings, each parallel to the pavement surface and to the center line of the pavement and shall be rigidly secured in the required position by such means as indicated that will prevent their displacement during placing and finishing of the concrete.

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.

When welded wire fabric is selected, the Contractor shall pour the lower half of the slab; place the welded wire fabric and then place the remaining concrete. Tie bars shall be installed in the required position by the method and device indicated. Bar coating indicated and of material specified, shall be completed and the bars and coating shall be free of dirt or other foreign matter at the time of installation in the concrete. Dowel bars shall be accurately installed in joint assemblies as indicated on the drawings, each parallel to the pavement surface and to the center line of the pavement and shall be rigidly secured in the required position by such means as indicated that will prevent their displacement during placing and finishing of the concrete.

**407.3.B.4. Joints:** 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.

**407.3.B.4.a. 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 1/8-in. to 1/4-in. below the pavement surface at the center of the joint. Expansion joints shall be installed perpendicularly to the surface and to the centerline of the pavement at the locations shown on the plans.

When no transverse joints are indicated, joints shall not exceed 40 feet. Such stakes, braces, brackets or other devices shall be used as necessary to keep the entire joint assembly in true vertical and horizontal position. Where concrete base is overlaid by asphaltic concrete, the joints to be prepared as specified herein, but joint sealing will not be required unless indicated.

**407.3.B.4.b. Joint Materials:** 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 1/2-in. below the finished surface of the pavement in order to allow the finishing operations to be continuous.

Where the joint filler is of a pre-molded 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. 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.

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

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 OWNER prior to extensive fabrication.

**407.3.B.4.c. 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 for Sawing. The joints shall be constructed by sawing to a 1/4-in. width and to a depth of 1/4 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 as sawing can be accomplished without damage to the pavement and before 24 hours after the concrete has been placed, 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 OWNER.

**407.3.B.4.d. 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.

Asphalt, Redwood board or other materials used shall extend the full depth of the concrete and shall be perpendicular to the exposed face. All joints shall be shaped to conform to the contour of the finished section in which they are installed. All material shall be a minimum of 1/2 inch thick or as indicated in contract documents. Wood materials shall be anchored to the adjacent concrete to permanently hold them in place. Joint sealer shall be installed in accordance with the manufacturer's recommendations.

Wooden bulkheads shall have a thickness of not less than 1 1/2-in. 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 1/4-in. 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. 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.

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., unless specifically authorized or directed by the OWNER in writing.

**407.3.B.4.e. Expansion Joints:** Transverse expansion joints shall be formed perpendicular to the centerline and surface of pavement and shall be constructed in accordance with the sequence of operations indicated on the drawings. After the transverse finishing machine and before the longitudinal finishing machine have passed over the joint, the Contractor shall test the joint filler for correctness of position and make any required adjustment in the position of the filler and shall install the joint seal space form as indicated on the drawings. After removal of the joint seal form as indicated on the drawings, the joint seal space above the joint filler shall be thoroughly sandblasted or machine routed to remove all projecting concrete, laitance, dirt or foreign matter. The concrete faces of the joint seal space shall be left true to line and section throughout the entire length of the joint. On completion of curing of the pavement, the joint sealing filler of the type specified shall be placed as indicated. The faces of the joint seal space shall be clean and surface dry at the time joint sealing filler is placed. On completion of the joint seal, the pavement adjacent to the joint shall be left free of joint sealing material. The joint seal space shall be exactly above and not narrower than the joint filler with no concrete over-hangings.

**407.3.B.5. Pouring:** The Contractor shall give the Engineer at least twenty-four (24) hours advance notice that he intends to pour concrete in any unit of the structure. The mixing of concrete and placing of same in the forms shall not be commenced until the Engineer has given his approval. No concrete shall be placed in any unit prior to completion of the form work and the placement of the reinforcing and other steel.

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 407.3.B.5.a. Concrete Temperature-Time Requirements will be rejected.

**Table 407.3.B.5.a. Concrete Temperature-Time Requirements**

<b>Concrete Temp (at point of placement)</b>	<b>Max Time - (min) (no retarding agent)</b>	<b>Max Time - (min) (no retarding agent)<sup>1</sup></b>
Non-Agitated Concrete All Temps	30	45
<b>Agitated Concrete</b>		
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 the Contractor's operations involve the placing of concrete from above directly into an excavated area or through the completion of forms, all concrete so placed shall be deposited through a vertical sheet metal or other approved pipe or tremie not less than six (6) inches nor more than ten (10) inches in diameter. The pipe shall be made in sections so that the outlet may be adjusted to proper heights during placing operations. Concrete shall be placed in continuous horizontal layers approximately (12) inches in thickness. The rate of delivery shall be so arranged that a cold joint is not allowed to form between loads. The Contractor shall avoid unauthorized construction joints by placing required portions of abutments, paving, piers, walls, floors, slabs columns or superstructures in one continuous operation. If required by specific jobsite conditions, openings in the forms shall be provided for the removal of laitance and other foreign material. 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.

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.

Any concrete not placed as herein prescribed within 30 minutes after mixing shall be rejected and disposed of as directed except as provided otherwise herein. If in the opinion of the Engineer or designated representative, the temperature, wind and/or humidity conditions are such that the quality of concrete will not be adversely affected, the specified placing time may be extended by a maximum of 45 minutes.

**407.3.B.5.b. Compaction:** All concrete shall be well compacted and the mortar flushed to the surface of the forms by continuous working with concrete spading implements and mechanical vibrators of an approved type. Vibrators of the type which operate by attachment to forms or reinforcement will not be permitted. The vibrators shall be applied to the concrete immediately after deposit and shall be moved throughout the mass, thoroughly working the concrete around the reinforcement, embedded fixtures, and into the corners and angles of the forms until it has been reduced to a plastic mass. The mechanical vibrator shall not be operated so that it will penetrate or disturb layers placed previously which have become partially set or hardened. The vibration shall be of sufficient duration to accomplish thorough compaction and complete embedment of reinforcement and fixtures, but shall not be done to an extent that will cause segregation. Vibration shall be supplemented by hand spading to insure the flushing of mortar to the surface of all forms.



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.

The use of rakes will not be permitted. Workers will not be permitted to walk in the concrete with any earth or foreign material on their boots or shoes.

**407.3.B.5.c. Weather Conditions:** Except by specific written authorization of the OWNER, no concrete shall be placed when the air temperature is less than 40°F and falling but may be placed when the air temperature is above 35°F and rising. The temperature shall be taken in the shade away from artificial heat. When and if such permission is granted, the CONTRACTOR shall furnish sufficient protective material and devices (canvas and frame work or other type of housing) 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 for a period of at least 5-days. Sufficient heating apparatus such as stoves, salamanders, or steam equipment and fuel to furnish all required heat shall be supplied. 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. The Contractor shall be responsible for the quality and strength of concrete under cold weather conditions and any concrete damaged by freezing shall be removed and replaced at the Contractor's expense.

Concrete shall not be placed when it's temperature is greater than 95°F. During hot weather placement additional steps shall be taken to insure proper curing, including, but not limited to, the use of ice in the batch process, white pigmented curing compound, dampening of forms, steel, and subgrade beneath concrete. Additionally, placement of wet burlap on the surface of concrete, fogging or wet curing may be used and maintained for a minimum of 7 days.

**407.3.B.6. Finishing:** As soon as concrete placing operations have been completed for a slab section of sufficient width to permit finishing operations, the concrete shall be approximately leveled and then struck, off, tamped, and screeded using a longitudinal screed. The screed shall be of a design adaptable to the use intended, shall have provisions for vertical adjustment, and shall be sufficiently rigid to hold true to shape during use.

Finishing shall be done on all exposed surfaces up to 1-ft below finished grade.

Tamping and screeding operations shall be continued until the concrete is properly consolidated and the surface voids are eliminated. The surface shall then be brought to a smooth true alignment by means of longitudinal screeding, floating, betting, and/or other methods approved by the Engineer. When templates are used, they shall be of such design as to permit early removal in order to avoid construction joints and to permit satisfactory finishing at and adjacent to the site of the template.

While the concrete is still workable, it shall be tested for irregularities with a 10-ft. metal 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 from the nearest point of contact. In no case shall the maximum ordinate to a 10-ft. straightedge be greater than 1/8-in. Any surface not within the tolerance limits shall be reworked and refinished.

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 non-workable. All such work shall be left smooth and true to lines.

**407.3.B.6.a. Texturing:** After completion of the straightedge operation, as soon as construction operations permit, texture shall be applied with 1/8 inch wide metal tines with clear spacing between the tines being not less than 1/4 inch nor more than 1/2 inch. If approved by the Engineer or designated representative, other equipment and methods may be used, provided that a surface texture meeting the specified requirements is obtained. The texture shall be applied transversely.

It is the intent that the average depth resulting from the number of tests directed by the Engineer or designated representative shall not be less than 0.060 inch with a minimum texture depth of 0.050 inch for any one test when tested in accordance with TxDOT Test Method Tex-436-A. Should the texture depth fall below that intended, the finishing procedures shall be revised to produce the desired texture.

The Contractor shall have available at all times hand rakes with tines for the purpose of providing textures in the event of equipment breakdown. The Contractor also shall have available a conventional garden spray type can, containing a commercially available monomolecular film compound. This shall be applied in the case of equipment breakdown or other emergencies to prevent the pavement from drying too rapidly. The use of this product will give the Contractor additional time to provide adequate texturing.

After completion of texturing and about the time the concrete becomes hard, the edge of the slab and joints shall be carefully finished with an edger and the pavement shall be left smooth and true to line.

**407.3.B.6.b. Stamping:** All concrete including curbs, curb with gutter, sidewalks, alleys, driveways and other 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.

**407.3.B.6.c. Hand Finishing:** 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 striking off 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.

### 407.3.C. Curing Concrete

All concrete pavements shall be cured by protecting it against loss of moisture for a period of not less than 72 hours from the beginning of the curing operations. Immediately after finishing operations have been completed, the entire surface of the newly laid concrete shall be covered and cured in accordance with the requirements specified for whichever of the following methods the Contractor may elect. The curing method as herein specified does not preclude the use of any of the other commonly used methods of curing, and the OWNER 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 OWNER shall have the right to order that another method of curing be instituted.

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.

Immediately after removal of the side and end forms of non-exposed surfaces, and after required finishing of exposed surfaces, the formed surfaces of all concrete shall receive a like coating. The solution shall be applied under pressure with a spray nozzle in such a manner as to cover the entire exposed surface thoroughly and completely with a uniform film.

The rate of application shall be such as to insure complete coverage, but the area covered shall not exceed two hundred (200) square feet per gallon of curing compound. The coating shall be sufficiently transparent and free

from permanent color to result in no pronounced change in color from that of the natural concrete at the conclusion of the curing period. It shall, however, contain a fugitive dye of color strength to render the film distinctly visible on the concrete for a period of at least four (4) hours after application.

Under normal conditions, the curing compound, after application, shall dry to touch within one (1) hour and shall dry thoroughly and completely within four (4) hours. When thoroughly dry, it shall provide a continuous flexible membrane free from cracks or pinholes and will not disintegrate, check, peel, or crack during the required curing period. If for any reason the seal is broken during the curing period, it shall be immediately repaired with additional sealing solution.

All concrete shall be cured and sealed with a continuous acrylic membrane-forming compound meeting the requirements of ASTM C-309. Products shall be Sealco 309 by Gifford-Hill; Horn Clear Seal by W.R. Grace and Company, or an approved equal.

Bonding agent shall be a liquid polymer latex compound such as Daraweld-C manufactured by W.R. Grace and Company or an approved equal.

#### **407.3.D. Opening 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 OWNER. In all cases the pavement shall be cleaned and joints shall be filled and trimmed before being opened to traffic.

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.

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.

#### **407.3.E. Testing and Evaluation**

All testing shall be in accordance with applicable ASTM Standards and concrete testing technician must be ACI certified or equivalent.

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 OWNER 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.

**407.3.E.1. Deficient Pavement:** The adjustment in unit prices provided for in this item will apply only when measurement for payment is by the square yard. It is the intent of this specification that the pavement be constructed in strict conformity with the thickness, strength and typical sections indicated on the drawings. Where any pavement is found not so constructed, the following rules relative to adjustment of payment for acceptable pavement and to replacement of faulty pavement shall govern.

The pavement will be core drilled after any grinding operations have been completed for surface corrections prior to final acceptance. Locations of core tests may be selected by the Engineer or designated representative; however, spacing interval for core tests, as specified herein, shall be maintained. The

thickness of the pavement will be determined by measurement of the cores in accordance with TxDOT Test Method Tex-424-A.

One core will be taken at the location selected by the Engineer or designated representative or at random in each unit. If the measurement deficiency of the core is less 0.2-in from the plan thickness, full payment will be made. When the measurement of the core is deficient more than 0.2 inch but less than 0.75 inch from the plan thickness, 2 additional cores (at directed locations) will be taken from the unit and the average of the 3 cores determined. The 2 additional cores from any 1,000-foot unit will be taken at intervals of not less than 300 feet. The 2 additional cores from any 1,000 square yard unit will be taken at locations such that the pavement in the unit will be well represented. If the average measurement of these 3 cores is not deficient more than 0.2 inches from the plan thickness, full payment will be made. If the average thickness of the 3 cores is deficient by more than 0.2 inch but not more than 0.75 inch from the indicated thickness, an adjusted unit price as provided below will be paid for the areas represented by these cores.

After any grinding or milling operations have been completed to meet the surface-testing requirement of this specification, if average thickness of pavement is deficient in thickness by more than 0.2 inch, but not more than 0.75 inch, payment will be made at an adjusted price as specified in the following table:

**Table 407.3.E.1.a. Concrete Pavement Thickness Deficiency**

<b>Thickness Deficiency (in)</b>	<b>Contract Price Allowed (%)</b>
0.00 to 0.20	100
0.21 to 0.30	80
0.31 to 0.40	72
0.41 to 0.50	68
0.51 to 0.75	57

Any area of pavement found deficient in thickness by more than 0.75 inch but not more than 1 inch or 1/8 of the indicated thickness, whichever is greater, shall be evaluated by the Engineer. If, in the judgment of the Engineer, the area of such deficiency should not be removed and replaced, there will be no payment for the area retained. If, in the judgment of the Engineer, 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 indicated on the drawings.

If the average compressive strength based on concrete test cylinders at 28 days is less than the specified minimum strength of the concrete, then payment will be made at an adjusted price as specified in the following table. The Ratio shall be that of the Average Strength from Test Cylinders to Specified Minimum Compressive Strength both at 28 Days.

**Table 407.3.E.1.b. Concrete Pavement Strength Deficiency**

<b>Ratio of Average Strength</b>	<b>Contract Price Allowed (%)</b>
0.95-1.00	100
0.90-0.95	85
0.85-0.90	70
0.80-0.85	60
Less than 0.80	0 or Remove and Replace

When, in the opinion of the Engineer or designated representative, the compressive strength test results appear unrepresentative, additional testing of field cores may be authorized. To be considered acceptable for consideration the field cores shall be acquired, properly handled and tested in accordance with ASTM C 42/C 42M, "Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete" within 45 days of the original concrete placement date. The retesting will be at the expense of the Contractor and the results of the retesting shall be averaged with the results of the original testing. If the results of retesting indicate that the original test results were erroneous by more than 15% in the opinion of the Engineer or designated representative, the original test results will be discarded. In the instance of erroneous original test results the subsequent first set of retests will be at the expense of the Owner.

When, in the opinion of the Engineer or designated representative, the concrete compressive strength is deemed unacceptable for the intended use of the pavement, the concrete shall be removed and replaced to the limits indicated by test results.

**407.3.E.2. Pavement Cracks:** Random drying shrinkage cracks or stress cracks of widths greater than 0.025-inches 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 OWNER.

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 OWNER. 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, 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 OWNER or its representative. Randomly cracked Portland cement concrete sidewalks will require removal and replacement of only the five-foot long section or sections containing random cracks.

#### 407.4 MEASUREMENT AND PAYMENT

When specifically included on the bid form as a pay item, concrete placed under this Section shall be measured complete in place by physically measuring the completed concrete structure after removal of forms and all required finishing has been completed. Length and width (or depth) shall be measured, and the constructed volume of the placed concrete shall be computed in square yards (SY). When not specifically included on the bid form as a pay item, there shall be no direct measurement of installed concrete, and all installed concrete not included in a specific bid item shall be paid as a subsidiary item to other bid items in the contract.

Concrete Pavement, if included in the bid, shall be measured as specified above and paid for at the contract unit price bid for "Concrete Pavement" which price shall be full compensation for shaping and fine grading the roadbed, including furnishing and applying all water required; for furnishing, loading and unloading, storing, hauling and handling all concrete ingredients, including all freight and royalty involved; for placing and adjusting forms, including supporting material or preparing track grade; for mixing, placing, finishing, sawing, cleaning and sealing joints and curing all concrete; for furnishing and installing all reinforcing steel; for furnishing all materials for sealing joints and placing longitudinal, expansion and weakened plane joints, including all steel dowel caps and load transmission devices required and wire and devices for placing, holding and supporting steel bars, load transmission devices and joint filler material in proper position, for coating steel bars, all other materials and methods, equipment, tools, testing, labor, and incidentals necessary to complete the work.

#### 408 SIDEWALKS, DRIVEWAYS, RAMPS, AND VALLEY GUTTERS

This item includes sidewalk, concrete driveway approaches, barrier free access ramps, and valley gutter construction within public right-of-way. All sidewalks, drive approaches, barrier free access ramps, and valley gutters shall conform to the standard plans and details appended to these Standard Specifications.

### 408.1 MATERIALS

Materials for the various features of work under this item of these specifications shall meet the following requirements:

- A. Concrete shall conform to the requirements of Item 407, "Concrete Pavement".
- B. Flexible Base Material shall conform to the requirements of Item 403, "Flexible Base".

**408.1.A. Reinforcing:** Driveway approaches and walk reinforcing, when required, shall be No. 3 bars on 24-in. centers or No. 4 on 30-in. centers. No. 6 gauge, 6-in. x 6-in. wire fabric conforming to Item 407.1.F. Reinforcing may be used only as approved by the OWNER.

Sidewalk reinforcing (except in driveway approach) may be No.3 bars on 24-in. centers or No. 10, 6-in. x 6-in.

All excavation, construction of fills or embankments and grading within the, public right-of-way shall conform to the appropriate section(s) of the standard specifications.

### 408.2 CONSTRUCTION METHODS

Construction of concrete valley gutters, sidewalks, barrier free access ramps, and concrete driveway approaches shall conform to the following requirements. Concrete shall be Class A as specified under Item 407, "Concrete Pavement", of these Standard Specifications. No concrete shall be placed until the forms have been checked and approved by the City Inspector. Dimensions and conformation shall comply with the details in the approved plans or Standard Details appended to these specifications. Grades, alignment, and tolerances shall be as specified.

Forms shall be of wood or metal, of a section satisfactory to the Engineer, straight, free of warp and of a depth equal to the depth of the concrete face. They shall be securely staked to line and grade, and maintained in a true position during the depositing of concrete. Thin plywood, steel, or other similar material may be used to form short radius curb returns at concrete driveway approaches. The reinforcing steel shall be placed in position as shown on the details in the approved plans. Care shall be exercised to keep all steel in its proper location during concrete placement.

Concrete surface shall be floated with a steel trowel to provide a smooth, burnished surface. After floating and before the finish has set, the surfaces shall be lightly brushed with a fine brush to remove the surface. After the surface has become firm, the surface shall be given a single floating with a wood float to provide a uniform surface.

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 0698 Test Methods, from -2 to +4 of optimum.

#### 408.2.A. Valley Gutters

Concrete Valley Gutters shall be constructed in accordance with details in the approved plans or Standard Details and to the grades indicated on-the plans. Transitions to and from the standard curb and gutter sections at each end shall be such that water will not be trapped in the gutter section. The structure shall be monolithic with the curb and gutter at either end. Valleys shall have a wood float finish with transverse tooled joints as shown in the details. Steel reinforcement shall be provided as shown.

#### 408.2.B. Sidewalks, Driveways, and Ramps

Sidewalks, barrier free access ramps, and Concrete Driveway Approach shall conform to the details in the approved plans or Standard Details appended to these specifications. The subgrade shall be compacted uniformly to the approximate density of the surrounding undisturbed material, and a one (1) inch sand cushion provided on the subgrade. Wire mesh reinforcement shall be provided in both sidewalks and concrete driveway approach. Reinforcing shall conform to the details in the approved plans or Standard Details appended to these

specifications. Expansion joints shall be installed at the intersection of drives and walks as indicated on Item 407, where cold joints occur, and where walks or drives abut other concrete structures. Walks and drives shall have a light brush finish as specified under Item 407, of these specifications. The edges shall be tooled with a one-quarter (1/4) inch radius edging tool, and walks shall also be tooled transversely at five (5) foot intervals. This pattern shall be continued through the concrete driveway approach apron. Curing compound shall be applied to the surface immediately after finishing is completed.

**408.2.B.1. Sidewalks:** Concrete sidewalks shall have a minimum thickness of 4-in., except 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 1/4-in. per-ft. in the direction of the curb or perpendicular to sidewalk direction, with a tolerance of 1/8-in. per-ft. When sidewalk is against the curb, expansion joints and tooled grooves shall match those in the curb.

**408.2.B.2. Ramps:** 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 OWNER, 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.

**408.2.B.2. Driveways:** 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. 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 for Sawing. Alternately, the OWNER may approve use of equipment designed to cut concrete curbs. All faces and edges exposed as a result of cutting shall be smoothed.

### **408.3 MEASUREMENT AND PAYMENT**

All Concrete Valley Gutters, Sidewalks, and Concrete Driveway Approach will be measured per square yard (SY) complete in place.

All barrier free access ramps will be measured per Each (EA) complete in place.

Price of Concrete Valley Gutter, Sidewalks, ramps, and Concrete Driveway Approach if included in the bid, shall be measured as specified above, which price shall be full compensation for all work herein specified, including the furnishing of all materials, equipment, tools, labor, and incidentals necessary to complete the work.

## **409 CONCRETE CURB AND GUTTER**

This item shall consist of Portland Cement concrete curb or curb and gutter with reinforcing steel as required, constructed on an approved subgrade and base in accordance with this specification and in conformity with the lines, grades, section and details indicated or as established by the Engineer.

### **409.1 MATERIALS**

Materials for the various features of work under this item of these specifications shall meet the following requirements:

- A. Concrete and reinforcing shall conform to the requirements of Item 407, "Concrete Pavement".
- B. Flexible Base Material shall conform to the requirements of Item 403, "Flexible Base".
- C. Reinforcing steel shall conform to Item 407, "Concrete Pavement". 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., whichever is greater.
- D. Expansion joint materials shall conform to Item 407, "Concrete Pavement".

#### 409.2 CONSTRUCTION METHODS

This section is intended to comply with section 402, 403, and 407. If anything in this section appears to contradict the above sections then the CONTRACTOR shall bring it to the attention of the OWNER for further guidance. Subgrade for curb and gutter shall be excavated and prepared to required depth and width including a minimum of 12 inches behind the curb, unless a greater width is indicated, to construct the work to grades and dimensions indicated. If dry, the subgrade shall be sprinkled with water lightly before concrete is deposited thereon.

The reinforcing steel shall be placed in position as shown on the typical section. Care shall be taken to keep all steel in its proper location.

**409.2.A. Joints:** Expansion joint material, ½-in thickness, shall be provided at intervals not to exceed 40 feet and at intersection returns and other rigid structures, or matching abutting sidewalk joints and pavement joints, or as otherwise specified by the OWNER. The expansion joints in concrete pavement shall coincide with the expansion joints in the curb and gutter and sidewalk. Joints shall extend the full width and depth of the concrete.

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. Dowels shall be spaced in accordance with standard reinforcement steel specifications. The dowel shall be a minimum of 24-in. 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 free expansion. Dowels shall be supported by an approved method to provide a true horizontal and longitudinal alignment.

Weakened plane joints or tooled joints shall be made ¾ inch deep at 10-foot intervals or matching abutting sidewalk joints and pavement joints. All joint headers shall be braced perpendicular and at right angles to the curb.

Two round smooth dowel bars, ½ inch in diameter and 24 inches in length, shall be installed at each expansion joint. Sixteen inches of one end of each dowel shall be thoroughly coated with hot oil, asphalt or red lead, so that it will not bond to the concrete. The dowels shall be installed with a dowel sleeve on the coated end as indicated or equivalent as directed by the Engineer.

**409.2.A. Forms:** All forms shall be of well-seasoned 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. The length of the forms shall be not less than 10 feet. Flexible or curved forms shall be used for curves of 100-foot radius or less. Wood forms for straight sections shall be not less than 2 inches in thickness. Forms shall be clean, straight, free from warp and oiled with a light form oil. All forms shall be securely staked to line and grade and maintained in a true position during the depositing of concrete.

**409.2.B. Workmanship:** Concrete shall be placed in the forms, rodded and tamped to exclude all air and honeycomb. Not more than 1 hour after the concrete has been placed, a thin coating not more than ½ inch nor less than ¼ inch thick of finish mortar, composed of 1 part Portland Cement to 2 parts fine aggregate, shall be worked into the exposed faces of the curb and gutter by means of a "mule." After the concrete has become sufficiently set, the exposed edges shall be rounded by the use of an edging tool to the radii indicated. The entire exposed surface of the curb and gutter shall be floated to a uniform smooth surface, then finished with a camel hair brush to a gritty texture. The forms shall remain in place a minimum of 24 hours unless approved otherwise by the Engineer. After removal of the forms, any minor honeycombed surfaces shall be plastered with a mortar mix as described above. Excessively honeycombed curb and gutter, as determined by the Engineer, shall be completely removed and replaced when directed.



**409.2.A. Finishing:** After the concrete has been struck off and while it is still plastic, the exposed surfaces may be plastered with 1/4-in. 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 OWNER 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. straightedge, and the maximum distance from the straightedge to the concrete shall not exceed 1/4-in. All variations greater than specified shall be immediately corrected. All honeycombed areas disclosed by removal of forms shall be immediately chipped out and patched with Portland cement mortar.

After a minimum of 3 days curing and before placing the final course base, the curb shall be backfilled to the full height of the concrete, tamped and sloped as directed by the Engineer. The top 4 inches of backfill shall be of clean topsoil, free of stones and debris.

### **409.3 MEASUREMENT AND PAYMENT**

Accepted work as prescribed by this item will be measured by the linear foot (LF) of concrete curb and gutter, complete in place. The work, when direct payment is provided for in the Bid, performed as prescribed by this item will be paid for at the unit price bid per linear foot for "Concrete Curb and Gutter" and / or "Concrete Curb," which price shall be full compensation for all work for excavation, preparing the subgrade, for furnishing and placing all base material, reinforcing steel, dowels, expansion joint material, backfilling and for all other materials, manipulations, labor, tools, equipment and incidentals necessary to complete the work.

## **410 MEDIANS**

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

### **410.1 MATERIALS**

All material requirements for constructing concrete medians shall conform to the requirements of Item for Concrete Curb and Gutter. Where a monolithic concrete median is indicated, concrete and reinforcement shall match the adjacent pavement. Concrete material requirements shall be the same as those for Item for Concrete Paving.

### **410.2 CONSTRUCTION METHODS**

Excavation and fine grading shall be done according to Item for Unclassified Street Excavation, and shall be subsidiary to the item. Forms and concrete placement shall conform to the requirements of Item for 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.

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. center to center, as shown on the plans, or as directed by the OWNER. 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.

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 for Concrete Pavement.

### **410.3 MEASUREMENT AND PAYMENT**

Concrete median shall be measured by the square-yard (SY) complete in place.

Concrete header shall be paid per each (EA) complete in place.

The work performed and materials furnished as prescribed by this item, measured as provided for in this item, shall be paid for at the contract unit price bid for "concrete median," and "concrete header," which price shall be full compensation for constructing concrete median, concrete header, necessary excavation, and for preparing the subgrade; furnishing and placing all materials, reinforcing steel, including sand cushion, reinforcement and expansion materials; and for all manipulation, labor, tools, equipment and incidentals necessary to complete the work.

### **411 PAVEMENT REPAIR**

No interference with traffic flow on the thoroughfares and collectors shall be permitted during the hours of 6:30 a.m. to 9:30 a.m. and 3:30 p.m. to 6:30 p.m., Monday through Friday, unless directed otherwise by the OWNER. A traffic lane shall be considered satisfactorily open if it is paved with hot-mix or cold mix asphalt paving, or paved with another suitable material approved by the OWNER, or covered.

If the cut is to be covered, the CONTRACTOR shall use steel plates of sufficient strength and thickness to support all the traffic. A transition of hot-mix or cold-mix asphalt conforming to the requirements of Item for Asphalt Pavement shall be constructed from the top of the steel plate to the existing pavement to create a smooth riding surface. Exceptions to these specifications must be approved by the OWNER.

#### **411.1 REPAIR DIMENSIONS**

Exact pavement removal locations must be approved by the OWNER prior to construction. If multiple repairs are closer than 10-ft. apart from edge of one repair to the edge of a second repair, a continuous section shall be replaced.

##### **411.1.A. Concrete Repairs**

Sidewalks shall be removed and replaced to the nearest existing joint. No sidewalk or driveway section to be replaced shall be smaller than 30-in. in either length or width unless otherwise approved by the OWNER.

A gutter of at least 12-in. may remain, provided that the curb and gutter is not damaged by the construction activity. Damaged curbs shall be replaced at the expense of the CONTRACTOR.

In a concrete paved street or alley, no horizontal dimension of any cut along the street path shall be less than 3-ft. or no less than 1-ft. from the edge of the trench on each end, whichever is greater. Where saw-cut locations coincide with or fall within 3-ft. of the present location of dummy joints, cold joint, construction joints, expansion joints, or edge, removal shall be to the existing joint or edge. If the trench edge or point repair is located greater than 1-ft. from a lane line on the side of the line closest to the curb, pavement shall be removed and replaced from the curb to the lane line. If the edge of a trench or point repair is located less than 1-ft. from a lane line on the side of the line closest to the curb, pavement shall be removed and replaced from the curb to the 2<sup>nd</sup> lane line beyond the trench edge or point repair.

##### **411.1.B. Asphalt Repairs**

In an asphalt paved street or alley, no horizontal dimension of any cut along the street path shall be less than 4-ft. or no less than 2-ft. from the edge of the trench on each end, whichever is greater.

If the edge of a trench or point repair is located less than or equal to ½ lane width but greater than 2-ft. from a lane line, the lane-width of pavement shall be removed and replaced. If the edge of a trench or point repair is located less than 2-ft. from a lane line, the pavement shall be removed and replaced to ½ lane width on each

side. In the lane along the curb, if the trench edge or point repair plus 2-ft. toward the lane line is less than ½ lane width, pavement shall be removed and replaced from the curb to ½ lane width.

#### **411.2 SAWING**

This item shall apply in the removal of bituminous or concrete pavement, curb, gutter, sidewalk or driveways. This item shall also govern for the sawing of weakened plane joints (contraction joints). Sawing shall be in accordance with the requirements of this item unless otherwise shown on the plans or in the special provisions. The removal and replacement of portions of permanent pavement (Portland cement concrete or hot-mix asphalt), drives, slabs, sidewalks, etc. shall require a full-depth cut to be sawed by the use of an approved power driven concrete saw in accordance with this specification or as directed by the OWNER.

Sawing shall be considered subsidiary to the items requiring sawing if no pay item exists in the Contract.

##### **411.2.A. Equipment**

The saw shall be power driven, shall be manufactured especially for the purpose of sawing pavement, shall be suitable for the work to be performed including dust control and shall be maintained in good operating condition.

Saw blades shall make a clean, smooth cut, producing a groove 1/8-in. to 1/4-in. wide and to the full depth required by these specifications or as shown on the plans. The saw, with its control devices, shall be mounted on a sturdy frame supported on rubber-tired wheels.

##### **411.2.B. Construction Methods**

Dust and residues from sawing shall be prevented from entering the atmosphere or storm drain. The edge of pavements, curb, gutter, sidewalk and/or driveways shall be neatly sawed. Saw cuts shall be made perpendicularly to the surface to full pavement depth or as directed by the OWNER. The edges of pavement and appurtenances damaged subsequent to sawing shall again be saw cut to neat straight lines for the purpose of removing the damaged areas. Such saw cuts shall be parallel to the original saw cut. Concrete sidewalk or driveway to be removed shall be neatly sawed in straight lines either parallel to the curb or at right angles to the alignment of the sidewalk.

For repairs due to trench excavations the existing pavement shall be precut, sawed or scored so as to result in an even, straight cut. After completion of the trench backfill, and upon approval of the Engineer, on all paved streets other than gravel streets, the Contractor shall cut and excavate the surface and base of the streets back on each side of the trench to form a shoulder for the new base and surfacing. The base material shall then be replaced in three (3) inch layers tamped in place. Replaced base material shall comply with Item for Flexible Base, and in no case be less than 8 inches thick. On gravel streets, six (6) inches of road gravel shall be rolled in place to serve as a wearing surface. All cutbacks shall be to a neat, straight line, and the paving cut shall be made with a concrete saw and shall be parallel to the center line of the pipe. Removal of excess surfacing beyond the nominal limits of the ditch shall be kept to a minimum, and such areas shall be outlined with straight saw-cuts and included in areas to be repaired as described above. Base material shall be compacted to ninety-five (95) percent of maximum density as determined by TxDOT Test Method TX-113/114. The replaced surface course shall consist with Item for Hot Mix Asphaltic Concrete.

In all paved streets the trench shall be finished in a workmanlike manner consistent with the same type of roadway which was removed so that the underlying courses, as well as the wearing surface, shall conform to the remainder of the roadway and shall be equal in every respect to the improvements existing prior to excavation.

#### **411.3 MICRO-SURFACING AND SLURRY SEAL**

This item shall apply to all the specified work for pavement repair or rehabilitation via the use of Micro-Surfacing or Slurry Seal. The work covered by this specification includes testing, construction, and quality control required for the proper application of micro-surfacing and slurry seal treatment services. Both the Micro-Surfacing and the Slurry Seal shall consist of a mixture of an approved emulsified asphalt, mineral

aggregate, mineral filler, and water and specified additives, proportioned, mixed and uniformly spread over a properly prepared surface. The completed micro-surface shall leave a homogenous mat, adhere firmly to the prepared surface and have a skid resistant surface texture.

Micro-Surfacing: This blend is used to give maximum skid resistance and an improved wearing surface. An example would be on pavements which have high traffic volume. Rate of application: 20 pounds per square yard for residential streets and 25 to 28 pounds per square yard collectors and larger streets as indicated in the design documents.

Slurry Sealing: TYPE IIA: This blend is used to give maximum skid resistance and an improved wearing surface. An example would be on pavements which have highly textured surfaced and require this size aggregate to fill in the voids and provides an improved wearing surface. Rate of application: 20 to 22 pounds per square yard.

**411.3.A. Materials**

Before work commences, the CONTRACTOR shall submit a signed original of a mix design containing the test results and proportioning of the specific materials to be used on the project. This design shall have been performed by a qualified laboratory. Previous lab reports covering the exact materials to be used may be accepted provided they were made during the calendar year. This initial mix design will be done at the CONTRACTOR's expense. Upon receipt of the original mix design, an independent qualified laboratory selected by the City will perform tests using the same materials as used in the initial mix design for verification of the results. This testing will be done at the City's expense. No work will begin until all materials and/or mix design proportions have met the specifications as required. Once the materials are approved, no substitutions will be permitted unless first tested and approved by the methods stated above.

**411.3.A.1. Aggregates:** The mineral aggregate shall consist of a natural or manufactured crushed stone such as granite, slag, limestone or other high quality aggregates or a combination thereof that conforms to the quality requirement of ASTM Specification D1073 and shall be free of dirt, organic matter, clay balls, and adherent films of clay, dust or other objectionable material. The aggregate shall contain no free water.

Micro-Surfacing: Application Rate Lb. Sq. Yd. 25-Lbs to 28-lbs. One hundred percent (100%) crushed material from a single source is required. The gradation of the aggregate shall be per the table below:

**Table 411.3.A.1.a. Micro-Surfacing Aggregates Gradation Requirements**

<b>Sieve Size</b>	<b>Percent Passing</b>
3/8"	99-100
No. 4	86-94
No. 8	45-65
No. 16	25-46
No. 30	15-35
No. 50	10-25
No. 100	7-18
No. 200	5-15

Slurry Seal: Smooth textured sands of less than 1.25 % water absorption shall not exceed 50% of the total aggregate blend. Type IIA is a modification of ISSA Type II gradation to provide a coarser mix. The CONTRACTOR shall be required to utilize a screening plant at the stockpile site and all aggregate loaded for use shall first pass thru the screening plant to remove any oversized material. The size of the screen opening on the screening plant shall be appropriate for the gradation approved by the City. Residual Asphalt Content, 8% to 12% % Weight of Dry Aggregate; Application Rate Lb. Sq. Yd. 20-Lbs to 22-lbs. Based on Weight of Total Mix the gradation of the aggregate shall be per the table below:

**Table 411.3.A.1.b. Slurry Seal Aggregates Gradation Requirements**

Sieve Size	Percent Passing
3/8"	100
No. 4	85-100
No. 8	55-80
No. 16	35-60
No. 30	25-45
No. 50	18-30
No. 100	10-21
No. 200	5-15

**Table 411.3.A.1.c. Alternative Slurry Seal Aggregates Gradation Requirements**

Sieve Size	Percent Passing
3/8"	100
No. 4	85-100
No. 8	53-80
No. 16	30-60
No. 30	20-45
No. 50	15-30
No. 100	10-21
No. 200	5-15

**411.3.A.2. Mineral Filler:** The mineral filler shall be a recognized brand of Type I and II Portland cement with no entrained air that meets the requirements of ASTM D 242 if required by the mix design. 0.5% to 2% by dry weight of aggregate will be the range of mineral filler in the mix design. The mineral filler shall be considered as part of the dry aggregate.

**411.3.A.3. Water:** All water shall be potable and compatible with the micro-surfacing and slurry seal mix. Compatibility shall be ensured by the CONTRACTOR. The percent of water in the mix design shall produce proper mix consistency.

**411.3.A.4. Emulsified Asphalt:** The asphalt emulsion shall be homogeneous and show no separation after mixing.

**Micro-Surfacing:** The emulsified asphalt shall be a quick-set polymer modified cationic type CSS-1P, CQS-1HLM, or CSS-1EP (E-Flex or approved equal) emulsion and conform to the requirements specified in AASHTO M 208 and ASTM D 2397. It shall pass all applicable storage and settlement test. The polymer material shall be milled into the emulsion or blended into the asphalt cement prior to the emulsification process. The cement mixing test shall be waived.

**411.3.A.4.a. Alternate E-FLEX Emulsified Asphalt:** When specified, E-FLEX, CQS-1EP and shall meet the requirements shown in Table below. Asphalt emulsion delivered to the project shall be accompanied by a laboratory certification of analysis.

After recovering the residue from AASHTO R-78, the sample may be annealed prior to testing to remove any excess moisture and provide for a consistent sample. The annealing can be accomplished by placing 20 grams of residue in a 6 oz. metal container (approx. 3-inch diameter) and heating to 163 °C for no more than 15 minutes. The sample should be stirred with a spatula every 5 minutes. The sample can then be poured directly into a 25mm DSR silicone mold for evaluation.

Perform the mixture design using an AASHTO-accredited laboratory experienced in the design of microsurfacing systems. Provide the Engineer with representative samples of all component materials for verification of the mixture design, unless otherwise directed. Identify additives used to control mixture set times and cohesion, as determined by design testing, and provide acceptable limits. The Construction Division will verify the mixture design to ensure it meets the minimum requirements for wet track abrasion as recommended by manufacturer.

**Table 411.3.A.4.b. Polymer-Modified Cationic Emulsified Asphalt**

Property	Test Procedure	Emulsion	
		CSS-1EP	
		Min	Max
<b>Asphalt Base Properties</b>			
Original DSR, kPa ( $G^*/\sin\delta$ , 10 rad./sec) @ 76°C	T 315	1.00	
<b>Emulsion Properties</b>			
Viscosity, Saybolt-Furol, @ 122°F, SFS	T 59	15	150
Sieve Test, %	T 59		0.1
Storage Stability, 1 day, %	T59		1
Distillation test			
Residue by distillation, % by weight	T 59	62	
Oil distillate, % by volume of emulsion			0.5
Tests on Residue Properties from Low Temp Evaporation (AASHTO R-78 <sup>1</sup> ):			
MSCR @ 70°C, Recovery @ 3.2 kPa,%	T 350	80	
MSCR @ 70°C, J <sub>nr</sub> @ 3.2, 1/kPa	T 350		0.50
ODSR, kPa ( $G^*/\sin\delta$ , 10 rad./sec) @ 76°C	T 315	1	
ODSR, deg (phase angle $\delta$ , 10 rad./sec) @ 76°C			60

Slurry Seal: Typically grade CSQS-1EP, CSSQS-1HLM (Quick Set Low Viscosity, Hard Penetration Latex Modified) shall be used. Alternatives with prior approval from the City. As directed by the City, the grade of emulsion shall conform to the requirements specified in ASTM D 2397 for Cationic Emulsions. (Quick Set). The emulsion used shall be modified with latex (SBR) which shall be milled into the emulsion or blended into the asphalt cement prior to the emulsification process. It shall pass all applicable storage and settlement tests. The cement mixing testing shall be waived. Asphalt emulsion, type CSSQS-1HLM (Quick Set) shall be specified on all city streets to minimize the amount of time the street will be closed.

**411.3.A.5. Latex Modifier:** A 3% latex content based on bitumen weight, certified by the emulsion supplier, shall be milled into the asphalt emulsion. The Latex Modifier shall be certified from the emulsion supplier, along with special quick setting emulsifier agents, shall be milled into the asphalt emulsion. The emulsified asphalt shall be so formulated that when the paving mixture is applied with the relative humidity at no more than 50% and ambient air temperature of at least 75 degrees Fahrenheit, it will cure sufficiently such that uniformly moving traffic can be allowed on completed travel lanes within 1 hour after placement with no damage to the surface. If determined necessary by the City, the mixture properties shall be adjusted according to humidity conditions and ambient air temperatures to allow uniformly moving traffic on completed travel lanes within 1 hour after placement with no damage to the surface.

Any additive used to accelerate or retard the break-set of the slurry seal shall be approved by the mix design laboratory as part of the mix design. The amount and type of additive (if needed) will be shown in the mix design.

**411.3.A.6. Material Testing:** All materials which first meet all quality test specifications shall be shown in the mix design by type of material and recommended proportions of said material.

**411.3.A.6.a. Aggregate Testing:** All aggregate material testing shall be done per the chart below:

TEST	TEST METHOD		SPECIFICATION
	AASHTO	ASTM	
Gradation Analysis	T-27	C-136	See Gradation Chart
Sand Equivalent	T-176	D-2419	45% Min
Soundness	T-104	C-88	Sodium Sulfate: 15% max loss Magnesium Sulfate: 20%
Hardness	T-96	C-131	35% Max
Unit Weight	T-19	C-29	Lb/cu.ft

**411.3.A.6.b. Emulsion Testing:** All emulsion testing shall be done per the chart below:

TEST	TEST METHOD		SPECIFICATION
	AASHTO	ASTM	
Particle Charge		D-244	
Distillation Residue	T-59	D-244	Weight 62% Min
Saybolt Furol Viscosity @ 77°F SSF, sec	T-59	D-88	15-50
Sieve Test, Retained on 20 Mesh Sieve	T-59	D-244	0.1% Max
24-hr Storage Stability	T-59	D-244	1% Max
5-Day Settlement Test	T-59	D-244	5% Max

**411.3.A.6.c. Distillation Residue Testing:** All Distillation Residue testing shall be done per the chart below:

TEST	TEST METHOD		SPECIFICATION
	AASHTO	ASTM	
Penetration@77°F, 100g, 5-sec	T-49	D-243	40-90
Solubility in Trichloroethylene	T-44	D-2042	97.5% Min
Ductility, 77°F, cm	T-44	D-113	40 Min
Softening Point, degrees F (Ring and Ball)		D-2398	140°F Min.

**411.3.A.6.d. Micro-Surfacing Mixture Testing:** All material mixture testing shall be done per the chart below:

TEST	TEST METHOD		SPECIFICATION
	AASHTO	ASTM	
Set Time		D-3910	12-hrs Max
Cure Time		D-3910	24-hrs Max
Wet Stripping Test, % Coating	TB-114		80% Max
Wet Track Abrasion		D-3910	75 grams/sf Max

Set Time 30-min Blotter	TB-102		No Brown Strain
Displacement	TB-102		No Displacement
Water Resistance at 30-Min	TB-102		No Discoloration

**411.3.A.6.e. Slurry Seal Mixture Testing:** All material mixture testing shall be done per the chart below:

TEST	TEST METHOD		SPECIFICATION
	AASHTO	ASTM	
Consistency Test		D-3910	2-3 cm flow
Set Time		D-3910	12-hrs Max
Cure Time		D-3910	24-hrs Max
Wet Stripping Test, % Coating	TB-114		80% Max
Wet Track Abrasion		D-3910	75 grams/sf Max

**411.3.A.7. Material Storage:** The CONTRACTOR shall provide a suitable storage facility for all equipment and materials needed to perform the work. This site should be located as close as possible to the area of work being done to reduce turnaround time and ensure an acceptable rate of work. Any site selected shall be subjected to final approval by the City. Erosion control measures shall be implemented as needed to comply with applicable laws.

Precautions shall be taken to ensure the aggregate does not become contaminated with oversized rock, clay, silt or excessive amount of moisture. The stockpile shall be kept in areas that have good drainage. Segregation of aggregates proposed for use and as supplied to the mixing plant shall be uniform.

**411.3.B. Equipment**

All methods and equipment employed in performing the work shall be subject to the approval of the City before work is started and whenever found unsatisfactory, they shall be changed and improved as required. All equipment shall be maintained in a satisfactory condition.

**411.3.B.1. Mixing Equipment:** The mixing machine shall be equipped with a water pressure system and nozzle type spray bar to provide a water spray immediately ahead of and outside the spreader box with 0.05 to 0.15 gallons per square yard immediately ahead of the spreader box. The equipment shall adhere to the requirements below:

**411.3.B.1.a. Micro-Surfacing:** The material shall be mixed by a self-propelled micro surfacing mixing machine which shall be a continuous flow mixing unit able to accurately deliver and proportion the aggregate, emulsified asphalt, mineral filler and water to a revolving multi-blade mixer and discharge the mixed product on a continuous flow basis. The machine shall have enough storage capacity for aggregate, emulsified asphalt, mineral filler and water to maintain an adequate supply to the proportioning controls. The machine shall be equipped with self-loading devices which provide for the loading of all materials while continuing to lay micro-surfacing, thereby minimizing construction joints. Individual volume or weight controls for proportioning each material to be added to the mix shall be provided. Each material control device shall be calibrated and properly marked.

The aggregate feed to the mixer shall be equipped with a revolution counter or similar device so the amount of aggregate used may be determined at any time.

The emulsion pump shall be a positive displacement type and shall be equipped with a revolution counter or similar device so that the amount of emulsion used may be determined at any time.

The mixing machine shall be equipped with an approved fines feeder that shall provide a uniform, accurately metered, predetermined amount of specified mineral filler.



**411.3.B.1.b. Slurry Seal:** The slurry seal mixing equipment shall be a continuous flow mixing unit or continuous-run design machines as to give a uniform and complete circulation of the batch in the mixer, so as not to segregate the aggregate, but will provide a thorough and uniform free flowing mix with the asphalt and water. The units shall be equipped with approved devices so that the machine can be accurately calibrated and the quantities of material used can be determined.

The CONTRACTOR shall have a minimum of 1 Slurry Seal machines at the project site in good working condition each having a capacity of at least 8 cubic yards to assure enough production capability.

**411.3.B.2. Spreading Equipment:** The equipment shall adhere to the requirements below:

**411.3.B.2.a. Micro-Surfacing:** The surface mixture shall be spread uniformed by means of a mechanical type spreader box attached to the mixer, equipped with paddles to agitate and spread the materials throughout the box. A front seal shall be provided to ensure no loss of the mixture at the road contact point. The rear seal shall act as final strike off and shall be adjustable. The mixture shall be spread to fill cracks and minor surface irregularities and leave a uniform skid resistant application of material on the pavement, the longitudinal joint where two passes join shall be neat appearing, uniform and lapped. All excess material shall be removed from the job site prior to opening the road. The spreader box shall have suitable means provided to side shift the box to compensate for variations in pavement geometry.

**411.3.B.2.b. Slurry Seal:** The spreader box shall be equipped to prevent loss of slurry seal from all sides and with a flexible rear strike-off capable of being adjusted. It shall suitable means for side tracking to compensate for deviation in pavement geometry. The box shall be kept free of built-up asphalt and aggregate. The strike-off drag shall always be kept completely flexible.

**411.3.B.3. Auxiliary Equipment:** Suitable crack and pavement cleaning equipment, hand tools and any support equipment will be provided by the CONTRACTOR as necessary to perform the work. The CONTRACTOR shall use a vacuum equipped street sweeper to remove all swept debris. Sweeping of debris into the gutter shall not be permitted.

**411.3.B.4. Testing & Equipment Calibration:** Each Slurry unit to be used shall be calibrated in the presence of the City prior to construction. Previous calibration documentation covering the exact materials to be used may be accepted provided they were made during the calendar year. No machine shall be allowed to work on the project until the calibrations have been completed and/or accepted.

CONTRACTOR shall lay Test strips (location to be determined by the City) before construction begins. The City will observe the test strip for verification or rejection according to the specifications. Upon failure of any of the test, additional test strips will be laid at no cost to the City. The square yards of the first test strip will be measured and paid for at the contract unit price. (Keeping proper consistency is a major concern. A wet mix will cause an asphalt rich surface. Consistency can be checked in the field by making a line through the slurry-surface immediately behind the spreader box. If the line stays, the slurry is at a proper consistency level. If the line fills up, the slurry is too wet.)

### 411.3.C. Construction Methods

The CONTRACTOR shall notify all homeowners and businesses affected by the construction a minimum of 24-hrs in advance of the surfacing. Should the work not occur on the specified day, new notification will be distributed as required. Complete street closures are allowed when approved by the City in consultation with the City Engineer. In general, complete street closures are allowed on residential streets for more efficient and effective completion and for reduction of the project duration impact to the neighborhood.

All Micro-Surfacing/Slurry Seal will be applied between March 1 and December 1 unless otherwise approved by the City. The Micro-Surfacing/Slurry Seal will be placed on the location and within the time limits as specified by the City. The Slurry Seal shall be applied only when the air and pavement temperature is 50°F and rising. No Slurry Seal shall be applied when:

1. In the period following precipitation with water remaining on the surface to be coated.
2. In foggy conditions.
3. If there is a threat of rain before the slurry seal can fully cure.
4. If there is danger that the finished product will freeze within 24-hrs after application.
5. If weather conditions prolong opening to traffic beyond the time specified by the City.
6. Any base failures, severe pavement defects, or similar conditions which are present will be properly repaired by the City to ensure correct application and performance of the pavement material. CONTRACTOR shall notify the City if there are any such defects present and shall not proceed until they have been corrected.

**411.3.C.1. Temporary Markings:** Whenever the work causes obliteration of existing pavement markings or delineation, temporary markings or delineation shall be in place prior to opening the traveled way to public traffic. Lane line and centerline pavement delineation shall be provided at all times for traveled ways open to public traffic. Other markings such as crosswalks, stop bars, and pavement arrows shall be delineated prior to opening the roadway to public traffic if directed by the City.

All work necessary to establish satisfactory temporary marking and lane delineation shall be performed by the CONTRACTOR. Surfaces on which temporary marking and lane delineation is to be applied shall be cleaned of all dirt and loose material, and shall be dry when it is applied. Temporary markings and lane delineation shall be maintained until replaced with permanent markings.

Temporary lane delineation shall consist of either a 4-inch by 4-inch square stripe or a 4-inch reflectorized tab, as directed by the City. Temporary lane delineators shall be placed on lane lines and centerlines at longitudinal intervals of not more than 24 feet apart, or 12 feet apart on radii. The temporary markings and lane delineators shall be the same color as the lane line, centerline, or pavement marking being replaced.

Unless noted otherwise, temporary markings and lane delineation shall not be paid for as a separate pay item and shall be considered subsidiary to the contract unit price per square yard of Slurry Seal or Micro-Surfacing, which pay item shall be the total compensation for the furnishing of all labor, materials, tools, equipment, and incidentals necessary to locate, install, and maintain the temporary markings and lane delineation.

**411.3.C.2. Surface Preparation:** Immediately prior to applying the slurry seal, the pavement shall be thoroughly cleaned of all loose materials, vegetation, soil and other objectionable material. Any breakdowns, base failures, or other defects will be properly repaired by the city before application of the slurry seal begins. Manholes, valve boxes, grate inlet, and other designated objects shall be covered by the CONTRACTOR to ensure their integrity. After completion of slurry placement, the CONTRACTOR shall remove said covers so the objects protected will remain fully functional. Any objects damaged by the CONTRACTOR shall be repaired or replaced at no cost to the City.

If conditions require, the pavement shall be pre-wetted by fogging ahead of the spreader box. Water used in fogging the surface shall be applied so that the entire surface is damp with no flowing water in front of the box. Rate of spray: 0.05 to 0.15 gal/sq. yd. (or as directed by the City); no streaks, lumps, balls, or unmixed aggregated shall be permitted.

**411.3.C.3. Application:** The slurry shall be sufficiently stable during the spreading period so that the emulsion does not break, there is no segregation of the fines from the coarser aggregate and the liquid of the mix does not float to the surface.

No excessive buildup or unsightly appearance shall be permitted on longitudinal or transverse joint. An excessive overlap will not be permitted on longitudinal joints. The CONTRACTOR shall provide suitable width

spreading equipment to produce a minimum number of longitudinal joints throughout the project. Longitudinal joints shall be placed on lane lines when possible. If half passes are used, they shall not be the last pass of any paved area.

In areas where the spreader box cannot be used, the slurry shall be applied by hand squeegees to provide complete and uniform coverage. Any joint or cracks not dilled by the slurry shall be corrected by use of hand squeegees. Hand work shall be completed during the machine applying process. Due to difficulty in hand working micro-surfacing material due to the quickset nature of the emulsion, hand work areas should be kept to a minimum.

Straight lines along curb gutters and shoulder will be required. No runoff on these areas will be permitted. Lines at intersections shall be kept straight to provide a good appearance. Slurry shall be placed at the lip of the gutter or at a distance from the face of the curb as directed by the City.

All objects covered (manhole covers, valve covers, grate inlets, etc.) shall be restored to their original integrity. The CONTRACTOR shall remove all unused material and debris from the site prior to final acceptance.

**411.3.C.4. Curing:** All traffic shall be kept off the slurry until it has cured to a firm condition that will prevent damage to the Micro-Surfacing or Slurry. Any uncured slurry damaged will be repaired to the satisfaction of the City at the CONTRACTOR's expense.

For Micro-Surfacing the emulsified asphalt shall be so formulated that when the paving mixture is applied with the relative humidity at no more than 50% and ambient air temperature of at least 75°F, it will cure sufficiently such that uniformly moving traffic can be allowed on completed travel lanes within 1 hour after placement with no damage to the surface. Failure to comply with this requirement may result in cessation of all work until such time that the CONTRACTOR provides the proper adjustments in his operations. If determined necessary by the City, the mixture properties shall be adjusted according to humidity conditions and ambient air temperatures to allow uniformly moving traffic on completed travel lanes within 1 hour after placement with no damage to the surface. Failure to comply with this requirement may result in cessation of all work until such time that the CONTRACTOR provides the proper adjustments in his operations. Protect other locations subject to sharp turning or stopping and starting traffic for longer periods when necessary. Any uncured micro damaged will be repaired to the satisfaction of the City at the CONTRACTOR's expense.

#### **411.4 FOG SEAL**

This item shall apply to all the specified work for pavement repair or rehabilitation via the use of Fog Sealing. The work covered by this specification includes testing, construction, and quality control required for the proper application of treatment services.

##### **411.4.A. Materials**

Before work commences, the CONTRACTOR shall submit a signed original of a mix design containing the test results of the mix. The emulsion mix shall be a polymer-modified, fiber reinforced asphalt emulsion coating that is job-mixed with specially graded aggregate and applied to pavement surfaces. The result should be a durable, slip-resistant surface treatment that greatly extends pavement service life. Mix should meet ASTM D8099/D8099M-17 Standard Specifications for Asphalt Emulsion Pavement Sealer. Approved brands are Jennite AE and Liquid Road. All other materials must be re-approved by the City.

Pre-approved material color shall be satin black color.

**411.4.A.1. Aggregates:** The mineral aggregate shall consist of a natural or manufactured crushed stone such as granite, slag, limestone or other high-quality aggregates or a combination thereof that conforms to the quality requirement of ASTM Specifications and shall be free of dirt, organic matter, clay balls, and adherent

films of clay, dust or other objectionable material. The aggregate shall contain no free water. Sand or Aggregate shall have a typical AFS of 11-15 Mesh.

The gradation of the aggregate shall be per the table below:

**Table 411.3.A.1.a. Fog Seal Aggregates Gradation Requirements**

Sieve Size	Percent Passing
3/8"	100
No. 4	100
No. 8	100
No. 10	95-100
No. 12	90-98
No. 16	40-70
No. 20	50-80
No. 30	90-98
No. 50	95-99
No. 100	7-18
No. 200	95-100

**411.4.A.2. Storage:** In the liquid state, the mixture must be protected from freezing. Do not store in direct sunlight or where temperature exceeds 120°F.

**411.4.A.3. Testing:** The emulsion mixture is to meet the composition and performance standards listed below when tested according to the following ASTM methods:

- a. D140: Sampling of Bituminous Materials
- b. D244: Standard Test Methods for Emulsified Asphalts
- c. D529: Testing of Bituminous Materials
- d. D2939: Standard Test Methods for Emulsified Bitumen used as Protective Coatings

In the liquid state, the mixture must meet the following requirements when tested according to ASTM D2939:

**Table 411.4.A.3.a. Testing Result Requirements**

Requirement	Maximum	Minimum
Non-Volatiles	52%	50%
Water	50%	46%
Ash of Non-Volatiles	38%	34%
Specific Gravity	-	1.15

The cured coating should be a water-based material and to show no tendency to flash or ignite. The cured coating exhibits no penetration, blistering, loss of adhesion, nor tendency to re-emulsify after immersion for 24 hours. The emulsion mixture is to be considered nonhazardous when tested according to the EPA's TCLP.

The manufactures to provide the City a 2-yr written warranty prior to installation.

**411.4.B. Construction Methods**

The CONTRACTOR shall notify all homeowners and businesses affected by the construction a minimum of 24-hrs in advance of the surfacing. Should the work not occur on the specified day, new notification will be distributed as required. Complete street closures are allowed when approved by the City in consultation with the City Engineer. In general, complete street closures are allowed on residential streets for more efficient and

effective completion and for reduction of the project duration impact to the neighborhood. Night-time application is not allowed.

**411.4.B.1. Surface Preparation:** Surface must be clean and free from loose material and dirt. Cracks should be filled with Sealant Filler. On extremely weathered and oxidized pavement surfaces, tack coating (priming) may be beneficial. Material shall not be applied when temperature (surface and ambient) is expected to drop below 50°F during application and for a period of at least 24 hours after application. Both surface and ambient temperature shall be a minimum of 50°F and rising during application.

**411.4.B.2. Application:** Properly mix mixture and apply one gallon of the mixture to cover approximately 36-45 square feet (4-5 square yards) per coat, or as recommended by the manufacturer. Application shall be done as recommended by the manufacturer assuming high traffic areas.

Apply first squeegee/brush coat of mixed at a rate of 30-40 square feet (3.3 to 4.4 square yards) per gallon. Allow first coat to dry thoroughly before applying second coat. Apply second squeegee/brush coat of mixed at a rate of 30- 40 square feet (3.3 to 4.4 square yards) per gallon. Allow second coat to dry thoroughly before opening to traffic.

Use 100% Acrylic Traffic paint for line striping and traffic markings.

When tested according to ASTM D2939, "set to touch" in 1 hour, exhibit "final set" in less than 8 hours.

#### 411.5 JOINT AND CRACK SEALING

This item shall govern the cleaning and/or sealing of joints and cracks that are (typically 1/16 inch or greater) in asphaltic concrete pavement, with HOT POURED Sealant, in conformity to the lines, grades and details indicated on the Drawings or as established by the Engineer or designated representative. This specification is applicable for projects or work involving either inch-pound or SI units.

##### 411.5.A. Materials

Joints and/or cracks shall be sealed with the materials indicated on the Drawings.

**411.5.A.1. Submittals:** The submittal requirements of this specification item include:

- a. Sealant Type (Polymer Modified Emulsion, Rubber-Asphalt or Self-Leveling Low Silicone) and method of application (crack sealing, joint sealing, squeegee, etc),
- b. Manufacturer certification that the product to be supplied meets or exceeds the specification requirements,
- c. Manufacturer recommended procedures for preparation, dispensing, application, curing etc. of the sealant, and
- d. Listing of the equipment proposed for the Work.

Fine aggregate used to cover the crack-sealing compound shall meet with the approval of the Engineer or designated representative. The sealing compound shall be delivered in the manufacturer's original sealed containers. Each container shall be legibly marked with the name of the manufacturer, the trade name of the sealer, the manufacturer's batch number or lot, the pouring temperature, and the safe heating temperature.

**411.5.A.2. Equipment:** Equipment, tools and machinery necessary for proper prosecution of the Work shall be on the project and shall be approved by the Engineer or designated representative prior to the initiation of the joint and crack cleaning and sealing operations:

**411.5.A.2.a. Polymer Emulsified Emulsion:** Polymer Emulsified Emulsion may be heated in a conventional asphalt distributor or in an asphalt heater equipped with an agitator to ensure that the emulsified

asphalt is circulated during the heating process and achieves a uniform temperature rise. Temperature gauges shall be provided at strategic locations to enable the operator to accurately control the temperature of the emulsion to avoid overheating the material. The unit shall be equipped with a gear-driven asphalt pump with adequate pressure to dispense the emulsion in joints and cracks.

**411.5.A.2.b. Rubber-Asphalt Crack Sealing Compound:** The sealant shall be heated in a double jacketed heater using a heat transfer oil so that no direct flame is in contact with the shell of the vessel containing the sealing compound. The heater reservoir shall be equipped with an agitator to ensure that the sealing compound is circulated during the heating process to achieve a uniform temperature rise and to maintain the desired temperature. Accurate temperature gauges and positive temperature controls shall be provided to monitor the temperature of the vessel contents and prevent overheating the material. The heater shall be equipped with a gear-driven asphalt pump with adequate pressure to dispense the rubber-asphalt crack sealing compound. The material should be maintained between 350°F and 375°F

**411.5.A.2.c. Self-Leveling Low Modulus Silicone:** The sealant shall be prepared and dispensed using the manufacturer's recommended equipment.

**411.5.A.2.d. Joint and Crack Cleaning Equipment:** All equipment used in cleaning joints and cracks shall be capable of delivering a enough volume of filtered air, free of oil, water or other contaminants, to insure the removal of all loose debris from the joints or cracks to be sealed. When specified on the Drawings, joints shall be routed. The router shall be of enough size to rout the joints to the widths and depths shown on the Drawings.

#### 411.5.B. Construction Methods

The Contractor may propose a different method of construction other than detailed herein for approval. No work shall commence using different construction methods unless the City Engineer approves said method.

Pavement and cracks shall be dry, and the ambient temperature shall be no less than 45°F and rising or 50°F and falling. No sealing of any joints or cracks shall be done when the joints or cracks are damp, unless drying of the joints and cracks with compressed air can be demonstrated and meets with the approval of the Engineer or designated representative.

Crack sealing should generally be done during the winter months when the cracks are open; and thus, sealant can more easily penetrate the crack.

**411.5.B.1. Crack Cleaning:** The bonding surface of cracks and joints shall be cleaned of infiltrated material with compressed air or other methods approved by the Engineer or designated representative to a depth at least twice the joint or crack width. When routing of the joints is indicated on the Drawings, the joints shall be routed and blown clean with filtered compressed air. Airflow should be free of oil and moisture and the compressed air should have a minimum pressure of 100-lb/in<sup>2</sup> and minimum blast flow of 150 ft<sup>3</sup>/min. These blasting operations are to always be directed away from passing traffic.

All material removed from joints and cracks shall be removed from the paved surface of the roadway. If dry mud or other organic material is visible inside the crack, then Contractor shall use a metallic brush and attempt to remove such material before sealant can be placed. For drying, a hot air lance shall be used. Sealant should be placed immediately after crack cleaning.

**411.5.B.2. Sealant Application:** The joint or crack sealing material shall be Hot Poured and applied using a pressure nozzle. Polymer modified emulsion and rubber- asphalt crack sealing compound shall penetrate and completely fill each crack and/or joint. All cracks and/or joints filled with these materials shall be squeegeed. The amount of sealing compound used shall be limited so that after the squeegee has been applied, the finished band shall be no more than 1-1/2 inches (38 mm) wide and shall not exceed a depth of 1/8 in. (3.2 mm) above the pavement surface. The squeegee should be kept over the center of the crack channel and as close

as possible to the applicator wand so that the sealant is fluid and workable. It is critical that the squeegee work be completed immediately after the sealant is placed and before it cools.

Excess sealant should be removed before hardening occurs. An over-band should be formed during, or immediately after, sealant application. The over-band should not be more than 3 inches wide.

When the number of cracks is so great that crack sealing in the manner described previously is impractical, the area shall be squeegee sealed. Areas to be squeegee sealed shall be indicated on the Drawings or established by the Engineer or designated representative. When all cracks in the area have been cleaned, the crack sealing material shall be applied, and the excess shall be squeegeed over the area between the cracks. All polymer modified emulsion or hot poured rubber squeegee sealed areas shall be covered immediately after application with a light coating of fine aggregate.

**411.5.B.3. Sand Aggregate Application:** A light coating of fine aggregate shall be applied to the cracks and joints before opening to traffic to prevent tracking. The fine aggregate (or sand), shall cover the entire area that has been affected by the sealant. The aggregate shall be dry, no larger than 1/16 inch, and applied immediately after the sealant has been leveled.

If the cracks are greater than 1/4" in diameter, or there are indicators of forming alligator cracks, the contractor shall apply angular crushed rock 1/8"-1/4" in diameter to the treated area, prior to opening to traffic.

**411.5.B.4. Safety:** During the sealing procedure, the materials and the equipment involved can present safety hazards to both workers and the traveling public. All safety precautions regarding material handling and the operation of the equipment should be strictly adhered to. Additionally, construction workers to wear safety apparel such as long sleeved shirts, leather gloves, steel toed boots, hard hats, and adequate eye protection.

**411.5.B.5. Traffic Control:** In order to ensure the safety of all workers and the traffic traveling near the work area, proper traffic control devices should be installed. The Texas Manual of Uniform Traffic Control Devices (MUTCD) provides guidance to use in implementing the traffic control plan. Contractor to consider the traffic volume and the curing time (or time between placement of sealant and removal of the traffic control devices) of the sealant selected for a work location. After application, CONTRACTOR shall open the treated section to the traffic within 30-min of application, but no sooner than 15-mi., allowing for cure time

#### 411.6 MEASUREMENT AND PAYMENT

If provided, the pavement repair shall be measured by the square-yard (SY) complete in place. If not provided in the contract documents, Pavement Repair shall be considered subsidiary to the items requiring repair if no pay item exists in the Contract.

If provided, the pavement crack sealing shall be measured by the square-yard (SY) of the entire pavement, regardless of the length and width of longitudinal cracks treated, complete in place.

The work performed, and materials furnished as prescribed by this item, measured as provided for in this item, shall be paid for at the contract unit price bid for "pavement repair," which price shall be full compensation for constructing pavement, necessary removal and excavation, saw cutting, temporary striping, traffic control, and for preparing the subgrade; furnishing and placing all materials, reinforcing steel, including sand cushion, reinforcement and expansion materials; and for all manipulation, labor, tools, equipment and incidentals necessary to complete the work.

#### 412 ROCK RIPRAP

This item shall include the construction of all Rock Riprap, and all of the materials, labor, and other incidentals required to complete the work at location specified by the Engineer.

### 412.1 MATERIALS

All Rock Riprap materials and construction shall conform to the Contract Documents.

- A. Geotextile Fabric – 6 OZ non-woven needle punch geotextile or as approved by Engineer.
- B. Clean native rock, size as indicated in the Contract Documents - as approved by Engineer.
- C. Grout – As indicated in item 405 and 407 with the use of only fine aggregates.

### 412.2 CONSTRUCTION METHODS

All Rock Riprap construction shall conform to the Contract Documents. Geotextile shall be placed in such manner that edge of geotextile is 12-in. from edge of rock riprap. Geotextile is not required if riprap is grouted. When geotextile is required, rock size shall be 6” min as measured on shortest axis.

### 412.3 MEASUREMENT AND PAYMENT

All Rock Riprap shall be measured by the square-yard (SY) complete in place.

Rock Riprap, if included in the bid, shall be measured as specified above and paid as described above, which price shall be full compensation for all work herein specified, including the furnishing of all materials, equipment, tools and labor and incidentals necessary to complete the work.

## 413 HIKE AND BIKE TRAIL

This item shall govern the furnishing and installation of hike and bike trails of the type and depth specified on a prepared surface to the typical sections and to the lines and grades indicated.

### 413.1 MATERIALS

Subgrade Preparation shall conform to Section for “Subgrade Preparation,” except that compaction requirements may be evaluated by either proof rolling or density testing, as established by the Owner. Any material necessary to establish the required grade shall conform to Item for Borrow.

Flexible Base shall conform to Item for “Flexible Base.” Concrete shall conform to Item for “Concrete Pavement.” Concrete Curb shall conform Item for “Concrete Curb and Gutter.”

Hot Mix Asphaltic Concrete shall conform to Item for “Hot Mix Asphaltic.” All Hot Mix used for Hike and Bike Trails shall be Type D with a minimum thickness of 1.5”.

Reinforcing steel and fiber reinforcing shall conform to Item for “Concrete Pavement.”

#### 413.1.A. Granite Gravel

The material shall be Texas decomposed unwashed granite aggregate and clay fines meeting the requirements hereinafter specified and shall be screened to the required particle size. The material shall be from approved sources.

Testing of granite gravel materials shall be in accordance with the following TxDOT standard laboratory test procedures:

1) Preparation for Soil Constants and Sieve Analysis	Tex-101-E
2) Liquid Limit	Tex-104-E
3) Plastic Limit	Tex-105-E
4) Plasticity Index	Tex-106-E
5) Sieve Analysis	Tex-110-E

Granite gravel material will be stockpiled and tested by the testing agency designated by the Owner and reviewed by the Owner prior to being hauled to the project site.



The material shall be well graded and when properly tested, shall meet the following requirements:

**Table 413.1.A.1. Granite Gravel Gradation Requirements**

<b>Sieve Size</b>	<b>Percent Passing</b>
5/8"	100
No. 40	40-45
No. 200	15-25
<b>Properties</b>	
Liquid Limit	35 Max.
Plasticity Index	12-18

**413.1.B. Submittals**

Prior to beginning construction, the Contractor shall submit to the Engineer for approval the following items:

1. Concrete: Concrete submittals shall be in accordance with Section 300 "Concrete."
2. Hot Mix Asphaltic Concrete: Hot Mix Asphaltic Concrete submittals shall be in accordance with Section 410 "Hot Mix Asphaltic Concrete."
3. Flexible Base: Flexible Base submittals shall be in accordance with Section 240 "Flexible Base."
4. Fiber Reinforcing: Fiber type, supplier, and product properties. Submit fiber documentation for compliance with this specification and ASTM C-1116.
5. Granite Gravel: Prior to construction, a sealed laboratory report shall be provided to verify compliance with the material requirements for granite gravel.

**413.2 CONSTRUCTION METHODS**

Granite gravel shall be compacted to not less than 92 percent of optimum density, as determined by TxDOT test method Tex-114, in accordance with ASTM D2167 Nuclear Test Method. Field density determinations shall be made in accordance with approved methods. Tests shall be performed at intervals not exceeding 500 feet at random points on the Hike and Bike Trail cross section.

When granite gravel is utilized as the finished surface for a Hike and Bike Trail, both sides shall be protected throughout the length of the trail by a concrete ribbon curb six inches in width, and shall match the depth of the granite gravel material. Alternatively, tightly fitted or mortared cut limestone blocks may be used, provided that no gaps larger than 1/4 of an inch are present between blocks. In addition, any areas with steep topography, or that may be subject to erosion potential, shall be required to have a concrete surface a minimum of four inches in depth.

**412.3 MEASUREMENT AND PAYMENT**

Hike and Bike Trail will be measured by the square yard (SY) of gravel area, complete in place regardless of depth required.

Concrete curbs, as prescribed by this item will be measured by the linear foot (LF), complete in place.

"Hike and Bike Trail," if included in the bid, shall be measured as specified above and paid for at the contract unit price bid for "Hike and Bike Trail" which price shall be full compensation for all work herein specified, including the furnishing of all materials, compacting, excavation, embankment, equipment, tools, labor, water for

sprinkling, proof rolling and incidentals necessary to complete the work. Payment for "Concrete," "Concrete Curb and Gutter," "Class B Borrow," "Reinforcing Steel," "Flexible Base," "Hot Mix," and "Subgrade Preparation" necessary constructing "Hike and Bike Trail" in accordance with this specification, shall be subsidiary to payment for "Hike and Bike Trail."

#### **414 PAVEMENT MARKINGS**

This item shall govern for the type, quality and application of paint or appropriate coatings for pavement surfaces. Such applications include liquid coatings and galvanizing. Items to receive applications may include, but are not limited to, bridges, barriers, concrete pavement, and asphalt pavement.

##### **414.1 DESCRIPTION**

Painting, coating and other protective treatments shall include, unless otherwise provided in the contract, the preparation of the surfaces; the application, protection and drying of the paint, coating(s) or treatments; the protection of all traffic upon, underneath, or near the structure, material or pavement; the protection of all parts of the structure, material or pavement against disfigurement by any and all painting operations; and the supplying of all tools, tackle, scaffolding, labor, workmanship, paint, coating and/or other materials necessary for the completion of the entire work in accordance with the plans and these specifications.

The intent of the design herein specified is to procure the paints, coatings or treatments on surfaces so that the durability and protective value of these designs shall be realized in service. Accordingly, the best quality materials and workmanship are implied throughout. Surface conditions and application requirements are specified with the intent to obtain full adhesion of paint, coatings or treatments to clean, dry, firm surfaces. This shall require careful attention to preparation of surface, to the prevention of contamination and marring of the coating during and after drying, and to uniform, skilled application.

Fire Lanes shall be installed in accordance with the International Fire Code (IFC), as well as the requirements set forth in the construction documents or referenced in the local governing authority's regulations and/or ordinances.

##### **414.1.A. Safety**

Some paints are harmful to the health. All paints shall be handled according to the information contained on the paint safety data sheet. The CONTRACTOR shall be responsible for safety during all cleaning and painting operations.

Unless shown otherwise on the plans, the CONTRACTOR shall be responsible for necessary precautions to contain refuse, dust and paint overspray generated during cleaning and painting operations. Containment shall be such that all falling material is contained and collected for disposal. Non-containment of airborne particles is permissible provided they are not visible over 100-feet from the actual cleaning or painting operation. A skimmer shall be used when cleaning and painting is over bodies of water. Disposal of collected refuse shall be in accordance with Federal, State and Local rules and regulations.

**If spray application is used, workers shall be adequately protected with respirators, and provisions shall be made to prevent infliction of harm upon all other humans and/or animals that might be exposed to the fumes or might eat food upon which the fumes have deposited. This warning shall absolve the OWNER from blame in the event of harm to persons or property from the named cause, and full responsibility for any such harm shall rest upon the CONTRACTOR.**

##### **414.2 MATERIALS**

All materials used in the painting and marking herein specified shall conform to the material and composition requirements of the applicable TxDOT Material Specification Item 666, Item 667, Item 672, Item 677, and Item 678.

##### **414.2.A. Striping**

Pavement Striping shall comply with:

- DMS-8200 Traffic Paint - Type II Marking Materials,
- DMS-8220 Hot Applied Thermoplastic - Type II Marking Materials,
- DMS-8240, Prefabricated Pavement Markings – Permanent,
- DMS-8241, Prefabricated Pavement Markings – Removable,
- DMS-8242, Temporary Flexible-Reflective Roadway Marker Tabs,
- DMS-8290 Glass Traffic Beads

Including any official TxDOT amendment or modification of these specifications, where reference to TxDOT or its representatives shall mean the OWNER. The CONTRACTOR shall certify to the OWNER that paint or coatings provided meet TxDOT material requirements.

#### **414.2.B. Raised Pavement Markers**

Raised Pavement Markers shall comply with TxDOT Item 672 and Specifications:

- DMS-4100, Jiggle Bar Tile,
- DMS-4200, Pavement Markers (Reflectorized),
- DMS-4300, Traffic Buttons,
- DMS-4210, Pavement Markers (Plowable Reflectorized),
- DMS-6100, Epoxies and Adhesives,
- DMS-6130, Bituminous Adhesive for Pavement Markers

The inspector will sample in accordance with Tex-729-I.

#### **414.2.C. Testing**

All paint and paint materials shall be sampled and tested prior to use. All tests shall be conducted in accordance with the methods specified by ASTM or methods set forth in Federal Standard FEDSTD-141 C/GEN Paint, Varnish, Lacquer, and Related Materials: Methods of Inspection, Sampling, and Testing. In the absence of any such methods, other suitable methods may be designated and utilized by the OWNER.

Raw materials and finished products that fail to meet any requirements of these specifications shall be subject to rejection. Final acceptance or rejection shall be based on results of tests on samples of raw materials and finishes as soon as practicable after their arrival at the shipping destination. Approval of materials, as a result of preliminary testing prior to manufacture into finished coatings, shall not be binding upon final approval or rejection. The judgment of the OWNER shall be final in all questions relative to conformance with the provisions of these specifications.

#### **414.3 EQUIPMENT**

Use equipment that is maintained in satisfactory condition, meets or exceeds the requirements of the National Board of Fire Underwriters and the RRC for this application, uses an automatic bead dispenser attached to the pavement marking equipment, and can provide continuous mixing and agitation of the pavement marking material. Provide a hand-held thermometer capable of measuring the temperature of the marking material when applying Type I material.

#### **414.4 CONSTRUCTION METHODS**

Throughout paint application, including shop and field painting, no paint shall be applied over a surface that evidences a loose or scaly condition. Every effort shall be made by means of the most effective and practical methods to remove all loose mill scale, rust, dirt, oil and grease, as well as all other foreign surfaces which would be deleterious to the procurement of the firm paint coating. Markings shall be applied only when the pavement surface is dry and clean, which may be accomplished with machinery specialized to prepare pavement in front of the marking operation. The CONTRACTOR shall comply with all environmental condition restrictions recommended by the manufacturer of pavement paints or other markings. Glass beads or other refractive material and application rates shall be as identified on the plans.

Temporary markings shall be thoroughly removed to the satisfaction of the OWNER using an approved method prior to the application of permanent markings.

When the CONTRACTOR is responsible for marking pavements, as identified in the plans, cleaning and marking shall conform to these specifications and the Texas Manual on Uniform Traffic Control Devices. Place markings before opening to traffic unless short term or work zone markings are allowed.

On roadways already open to traffic, place markings with minimal interference to the operations of that roadway. Use traffic control as shown on the plans or as approved. Protect all markings placed under open-traffic conditions from traffic damage and disfigurement.

#### 414.4.A. Surface Preparation

Unless otherwise shown on the plans, prepare surfaces in accordance with this section. When existing pavement markings are present, remove loose and flaking material. Ensure that the bond surfaces are free of dirt, curing compound, grease, oil, moisture, loose or unsound pavement markings, and any other material that would adversely affect the adhesive bond. Approved pavement surface preparation methods are sweeping, air blasting, flail milling, and blast cleaning unless otherwise specified on the plans.

**414.4.A.1. New Pavement Surfaces:** Air-blast or broom the pavement surface to remove loose material, unless otherwise shown on the plans. A sealer for Type I markings is not required unless otherwise shown on the plans.

Furnish raised pavement markers for each class from the same manufacturer. Place raised pavement markers on the new asphaltic concrete surface or surface treatment only after the new surface has aged at least 14 days. Surface shall be prepared in accordance with TxDOT Item 678.

**414.4.A.2. Old Pavement Surfaces:** For old surfaces and all concrete surfaces, clean in accordance with TxDOT Item 678, "Pavement Surface Preparation for Markings," to remove curing membrane, dirt, grease, loose and flaking existing construction markings, and other forms of contamination.

**414.4.A.3. Sealer for Type I Markings:** For old surfaces and all concrete surfaces, apply a pavement sealer before placing Type I markings on locations that do not have existing markings, unless otherwise approved. The pavement sealer may be either a Type II marking or an acrylic or epoxy sealer unless otherwise shown on the plans. Follow the manufacturer's directions for application of acrylic or epoxy sealers. When the sealer becomes dirty after placement, clean by washing as directed. Place the sealer in the same configuration and color (unless clear) as the Type I markings unless otherwise shown on the plans.

Apply markings on pavement that is completely dry and passes the following tests:

**414.4.A.4. Type I Marking Test:** Place a sample of Type I marking material on a piece of tarpaper placed on the pavement. Allow the material to cool to ambient temperature, and then inspect the underside of the tarpaper in contact with the pavement. Pavement will be considered dry if there is no condensation on the tarpaper.

**414.4.A.5. Type II Marking Test:** Place a 1-sf piece of clear plastic on the pavement, and weight down the edges. The pavement is considered dry if, when inspected after 15 min., no condensation has occurred on the underside of the plastic.

#### 414.4.B. Application

Establish guides to mark the lateral location of pavement markings as shown on the plans or as directed, and have guide locations verified. Use material for guides that will not leave a permanent mark on the roadway. Apply markings that meet the requirements of Tex-828-B, using information as shown on plans. Alignment must not deviate than 1 in. per 200 ft. of roadway or more than 2 in. max. Markings shall be clean and reflectorized.

**414.4.B.1. Weather Conditions:** Apply markings during good weather unless otherwise directed. If markings are placed at Contractor option when inclement weather is impending and the markings are damaged

by subsequent precipitation, the Contractor is responsible for all costs associated with replacing the markings if required. As a general rule if the material manufacturer does not establish temperature requirements, do not place material if the pavement temperature is below 60°F or above 120°F.

**414.4.B.1.a. Type I Markings:** Place the Type I marking after the sealer cures, and within the temperature limits recommended by the material manufacturer. If during a spray application, operations cease for 5 min. or longer, flush the spray head by spraying marking material into a pan or similar container until the material being applied is at the recommended temperature. Apply on clean, dry pavements passing the moisture test described above, and with a surface temperature above 50°F when measured in accordance with Tex-829-B.

**414.4.B.1.b. Type II Markings:** Apply on surfaces with a minimum surface temperature of 50°F and within temperature limits recommended by the material manufacturer.

**414.4.B.2. Application:** Apply markings and install markers as shown on plans. Do not make permanent marks on the roadway for the guides.

**414.4.B.2.a. Type I Markings:** Apply TY-I markings with a minimum thickness of 0.1-in. for new markings and retracing water based markings and 0.06-in. for retracing on thermoplastic pavement markings, or 0.09-in. for all other Type I markings. The maximum thickness for Type I markings should not exceed 0.18-in. as measured in accordance with Tex-854-B using the tape method.

**414.4.B.2.b. Type II Markings:** Apply TY-II markings at least 20 gal. per mile on concrete and asphalt surfaces for a solid 4-in. line. Adjust application rates proportionally for other widths. When Type II markings are used as a sealer for Type I markings, apply at least 15 gal. per mile using Type II drop-on beads.

**414.4.B.2.c. Beads:** Bead Application for Type I and Type II markings shall be provided with a uniform distribution of beads across the surface of the stripe, with 40% to 60% bead embedment.

**414.4.B.2.d. Raised Markers:** Epoxy adhesive and bituminous adhesive will be used for jiggle bar tile and reflectorized pavement markers. For traffic buttons on hydraulic cement concrete pavements and for plowable reflectorized pavement markers use only epoxy adhesive. For traffic buttons on bituminous pavements use only bituminous adhesive.

Apply adhesives in sufficient quantity to ensure that 100% of the bonding area of raised pavement markers is in contact with the adhesive. Do not heat bituminous adhesive above 400°F. Agitate bituminous adhesive to ensure even heat distribution. Place raised pavement markers immediately after the adhesive is applied and ensure proper bonding. Do not use adhesives or any other material that impairs the functional retro-reflectivity of the raised pavement markers.

#### 414.4.C. Testing

All markings and replacement markings must meet the requirements of Tex-828-B for at least 30 calendar days after installation. Markings should not lift, shift, smear, spread, flow, or tear by traffic action. Markings that fail these requirements within 30-days shall be removed and replaced according to this Item at CONTRACTOR'S expense.

#### 414.5 MEASUREMENT AND PAYMENT

Linear pavement markings shall be measured per Linear Foot (LF) of installed marking as measured along the centerline of stripe. Other markings and raised pavement markers shall be measured either per Each (EA) or per Lump Sum (LS).

Payment shall be made per unit described above and shall include any type, color specified and the shape, width, size, and thickness, all types of paint (TY-I, TY-II, Beads, Sealer), surface preparation, testing, and furnishing and placing all materials, tools, labor, for removing existing markers and markings; furnishing and installing raised pavement markers; and equipment, materials, labor, tools, and incidentals to complete the work.

#### 415 TRAFFIC CONTROL

This item shall consist of furnishing, installing and removing all temporary traffic control devices necessary to meet the requirements of the latest version of the Texas Manual on Uniform Traffic Control Devices (TMUTCD), and the requirements set in the traffic control plan.

##### 415.1 INSTALLATION

Temporary traffic control devices shall be installed as required before the beginning of any construction adjacent to active traffic lanes. Temporary traffic controls shall be modified as required at the beginning of each construction phase to comply with the construction phasing and actual traffic patterns to be accommodated. If at any time during the project, the temporary traffic controls are not installed or maintained in a manner consistent with the Contract Documents and the TMUTCD, the Engineer shall have the authority to order all work stopped until the temporary traffic controls are brought into full compliance. No additional contract time or extra pay shall be allowed for such shutdown periods.

Temporary striping shall be as denoted on the plans and shall conform to TxDOT Item 662 for Type II work-zone pavement markings.

##### 415.2 MEASUREMENT AND PAYMENT

Temporary traffic control devices will be measured by Lump Sum (LS), Per Month (Mo), or Per Each (EA), which shall include all maintenance, revisions, removal, and relocations.

Payment for all items and tasks described in this Specification Item shall include the cost of materials, labor and all incidental and subsidiary materials and work necessary to complete installation and meet all requirements as indicated.