

**PART 400  
PAVEMENT**

TABLE OF CONTENTS

SECTION	TITLE	PAGE(S)
401	Subgrade Preparation.....	3-4
402	Lime Treated Subgrade.....	5-8
403	Portland Cement/Fly Ash Treated Subgrade.....	9-14
404	Geogrid Reinforced Aggregate Base.....	15-18
405	Asphaltic Concrete Pavement.....	19-30
406	Portland Cement Concrete Pavement.....	31-38
407	Curb, Gutter, Driveway Approaches, Sidewalk and Wheelchair Ramps.....	39-44
408	Concrete Curing and Protection.....	45-46
409	Cold Milling Pavement.....	47-48
410	Cold Plastic Traffic Marking.....	49-52

This page was left blank for future use.

## SECTION 401

### SUBGRADE PREPARATION

#### 401.1 DESCRIPTION

This work shall result in bringing the subgrade under pavement to the proper distance below the grade of the finished pavement by excavating or filling as necessary and in preparing the subgrade material to support the proposed pavement. All excavation, preparation and completion of the roadway subgrade, water and material furnished, mixing, blading, rolling, cleaning, and furnishing tools and labor to complete this work is included.

#### 401.2 TESTING PROCEDURES

Tests used to determine optimum moisture content and standard density of the various soils shall conform to the methods set out in the latest revision of ASTM D-698 unless indicated otherwise on the plans. Tests used to determine optimum moisture content and standard density of the various soils shall conform to the methods set out in the latest revision of ASTM D-1557 when specified by the plans.

Laboratory determination of moisture content of the various soils shall conform to the latest revisions of ASTM D-2216. Field determination of the density of the various soils shall conform to any one of the methods specified in the latest revisions of ASTM D-1556, D-1267, or D-2922. Field determination of the moisture content of the various soils shall conform to any one of the methods specified in the latest revisions of ASTM D-2216 or D-3017.

#### 401.3 CONSTRUCTION REQUIREMENTS

##### Cut Sections

The earth below the finished pavement grade in cut sections shall be scarified, broken up and uniformly mixed for a minimum depth of six inches (6") and for a minimum distance of eight inches (8") beyond the back of curb lines, adjusted to a uniform moisture content as described in moisture control requirements (this section), and compacted to a density equal to or greater than ninety-five percent (95%) of standard density of the soil involved as determined by the Engineer. The top of the finished and compacted subgrade shall be slightly higher than the bottom elevation of the proposed pavement.

##### Fill Sections

Compacted fill shall be constructed as necessary to bring the subgrade to the proper elevation to support the pavement, including curb and gutter, by using excavated material for that purpose. The Contractor shall remove all sod and vegetable matter, all unstable material, and any other unsuitable material, as determined by the Engineer, from the surface upon which compacted fill is to be placed. The surface upon which compacted fill is then to be constructed shall be scarified and broken up to minimum depth of six inches (6"), adjusted to a moisture content of not less than five percentage points below the optimum moisture content of the soil involved as determined by the Engineer, and then compacted to the density requirement to which the subsequently placed compacted fill is to be constructed. Compacted fill shall be constructed of earth free from animal and vegetable matter and shall be deposited in layers of not more than six inches (6") in compacted thickness. Each layer shall be thoroughly leveled with a motor grader or bulldozer and completely compacted to the required density using a sheep's foot roller before the succeeding layer is placed.

Compacted fill shall be constructed to the line established by the bottom of the proposed pavement to a width of one foot (1') beyond the right-of-way line and then on a one-to-one slope down to the existing ground, unless otherwise shown on plans. The process of placing six inch (6") layers of earth, adjusting moisture content, and compacting the layers is to be continued until the surface of the fill is slightly above the bottom grade of the proposed pavement and to the width previously specified. The top six inch (6") layer of compacted fill upon which the pavement is to be placed for a width of eight inches (8") wider on each side of the proposed pavement shall be brought to the previously specified uniform moisture content and then compacted to a density equal to or greater than ninety-five percent (95%) of standard density of the soil involved as determined by the Engineer.

#### **Final Compaction and Grading**

When cut or fill operations are complete, the subgrade shall be graded to approximately the bottom of the proposed pavement. Prior to application of any stabilizing agent (if used), the entire subgrade must be rolled with a flat steel roller weighing not less than eight (8) tons or more than fifteen (15) tons, after which all unstable areas must be removed and replaced with suitable material, and all other areas that give under the weight of the roller shall be re-compacted or otherwise secured from settlement. All work required to stabilize the subgrade prior to the application of any stabilizing agent (if used) shall be at the contractor's expense. All earthwork must be completed to approximately the proper distance below the finished grade of the pavement and to the minimum widths specified prior to preceding with the next phase of construction on the subgrade and the Contractor shall obtain approval from the Engineer before proceeding with the next phase of construction. The subgrade must then be brought to a true grade immediately in advance of paving operations, using procedures previously described in this section.

#### **Trenches and Excavation**

It shall be the responsibility of the Contractor to insure that all trenches or excavations made in the subgrade are backfilled properly, adjusted to the required uniform moisture content, and compacted to the specified density. The top two foot layer of all trenches that have been sand filled and flushed shall consist of material identical to the surrounding subgrade and shall be compacted in the same manner as previously specified to the required density. The Engineer shall have full authority to determine the acceptability of all trench backfill.

#### **Moisture Control Requirements**

The moisture content of the soil being compacted shall be considered as being too high to insure compaction when after repeated rolling with the sheepsfoot roller, the roller continues to pick up excessive amounts of soil and refuses to "build up" so that the tamping feet eventually ride the compacted surface. When heavy clay soils are encountered actual moisture content of the soil shall be no more than two percentage points above the plastic limit of that soil during compaction.

When other types of rollers are used, the moisture content of the soil shall be considered as excessive when "bridging" or "building up" of the soil occurs in front of, or behind the wheels of such rollers, and/or when earth hauling equipment produces excessive ruts in the rolled surfaces.

#### **Frozen Soil**

When frozen soil exists in either the surface of the original ground or the surface of a partially constructed fill, work shall not proceed until such time that the frozen soil has completely thawed or been removed. Frozen soil shall not be used in constructing compacted fill.

## SECTION 402

### LIME TREATED SUBGRADE

#### 402.1 DESCRIPTION

This work consists of incorporating Carbide lime sludge, Hydrated lime or Pebble quicklime, as a stabilizing agent, into prepared roadway subgrades. Only one type of lime shall be used on each individual project.

#### 402.2 MATERIALS

##### General

The available lime index expressed as a percentage by weight of calcium and magnesium oxides (non-volatile basis) shall be determined by the "Rapid Sugar" test as set out in ASTM C-25. The lime supplier shall certify, in writing that the lime furnished meets the requirements specified below. The City reserves the right to sample the lime at the construction site and to test it to verify the certification.

##### Carbide Lime Sludge

Carbide lime sludge samples shall be submitted to the Engineer prior to construction to determine composition and application rate.

##### Hydrated Lime

Hydrated lime shall have a chemical composition such that the minimum available lime index shall not be less than ninety percent (90%). The fineness of the hydrated lime shall be such that not more than five percent (0.05%) will be retained on a No. 30 sieve or more than twenty percent (20%) will be retained on a No. 200 sieve.

##### Pebble Quicklime

Pebble quicklime shall have a chemical composition such that the minimum available lime index shall not be less than ninety percent (90%). The fineness of the pebble quicklime shall be such that one hundred percent (100%) will pass a 5/8-inch sieve and not less than eighty percent (80%) will be retained on a 1/4-inch sieve.

#### 402.3 SUBGRADE PREPARATION

Prior to the application of the lime, the subgrade shall be prepared as described in Section 401.

#### 402.4 APPLICATION

##### General

No lime shall be applied unless the temperature is at least forty (40) degrees F. in the shade, away from artificial heat, and rising, unless otherwise directed by the Engineer.

Lime shall be spread on the subgrade in the specified manner and in such a quantity that the required amount of lime can be incorporated into the subgrade soil. The application rate to be used will be determined by the Engineer consistent with the various types of subgrade soils. The soil, lime, and water shall be mixed by approved road mixers or other approved equipment until a uniform mixture is obtained and all clods and lumps are reduced to a maximum of two and one-half inches (2 1/2") diameter in size.

This mixture shall extend to a depth of six inches (6") and for a distance of eight inches (8") beyond the back of the curb lines of the pavement, unless indicated otherwise by the plans or contract.

#### **Carbide Sludge Lime**

Carbide lime sludge shall be spread using methods that have been approved by the Engineer which will result in the specified uniform rate of application. Continued use of methods which do not result in a uniform application will not be permitted. All particles of lime sludge shall be reduced to a maximum of 1/4-inch in size.

#### **Hydrated Lime**

Hydrated lime shall be mixed with water and applied using approved pressure distributing equipment. The slurry shall consist of a mixture of approximately one ton of lime to each five hundred (500) gallons of water but shall not contain more than forty percent (40%) lime. Agitation of the slurry mixture shall be accomplished by using paddles, recirculating pumps, or a combination of these devices. Constant agitation of the slurry mixture will be required to keep the lime and water in a uniform mixture. The use of compressed air to aid in the mixing of the slurry will not be permitted. Lime to be applied as a slurry shall be spread the same day that the slurry is mixed.

#### **Pebble Quicklime**

Quicklime shall be spread on the subgrade dry, using approved equipment that has demonstrated its ability to distribute the lime in controlled and uniform amounts. Water shall not be added to the quicklime until it is thoroughly mixed into the subgrade soil.

Dry lime shall not be applied when the wind conditions are such that blowing lime will be objectionable to traffic or adjacent property owners.

The quantity of water necessary for the first mixing operation will vary with the nature of the soil and normally will be three to five percent (3-5%) above the optimum moisture content of the treated soil mixture. Sufficient water shall be added during the first mixing process to insure proper chemical reaction between the lime and soil.

### **402.5 INITIAL CURING**

When proper first mixing has been accomplished, the mixture shall be placed in a windrow or spread over the roadbed and the surface sealed by lightly rolling with a flat steel wheel or pneumatic roller to retard the loss of moisture and aged for a period of not less than forty-eight (48) hours. The aging process may be shortened, with the approval of the Engineer, depending upon the type of soil involved. The mixed material shall be maintained in a moist condition of not less than two percent (2%) below optimum moisture during the aging process.

### **402.6 RE-MIXING AND COMPACTION**

After the required initial curing time, the soil-lime material shall be re-mixed and pulverized by approved methods until one hundred percent (100%) of the mixed material by dry weight passes a one and one-half inch (1 1/2") sieve and at least sixty percent (60%) by dry weight will pass a No. 4 sieve, exclusive of stone and gravel. The moisture content of the mixed material shall be adjusted during the final mixing process so that the moisture at the time of compaction will be within two percentage (2%) points above or below the optimum moisture of the mixed material.

Compaction and finishing operations shall proceed immediately upon completion of the final mixing. Sheepsfoot rollers shall be used in compaction operations so that the compaction of the mixture will begin at the bottom and shall continue until the entire depth of mixture is uniformly compacted to the specified density. The moisture content shall be maintained within two percentage (2%) points of the optimum moisture during compaction operations. The mixture shall be laid and compacted to a density of at least ninety-five percent (95%) of the standard density of the soil-lime mixture as determined by the Engineer. Light sprinkling may be required during laying and compacting operations to maintain the specified moisture content. Compaction shall be accomplished with sufficient blading to eliminate all irregularities. The surface shall be lightly scarified during finishing operations and bladed to eliminate any imprints left by the equipment. Final rolling of the completed surface shall be accomplished with a flat steel roller. The subgrade shall be brought to a true grade immediately in advance of placing pavement. The surface of the roadbed shall then be adjusted by cutting off the high areas and filling in the low areas as indicated by the screed or template. The fill in low areas is to be compacted to the same density requirement as previously specified.

#### **402.7 FINAL CURING**

Upon completion of the compaction and finishing of the treated subgrade no vehicles or equipment other than sprinkling equipment shall be permitted upon the treated subgrade for a period of seven days; however, the seven-day curing may be reduced to whatever period of time is required for the treated subgrade to gain sufficient stability to support the construction equipment if the construction of the pavement on the treated subgrade takes place in less than the seven-day period after the completion of the lime treatment. Any damage to treated subgrade due to other phases of construction shall be repaired at the Contractor's expense. The treated subgrade shall be cured by lightly sprinkling the surface with water at frequent intervals to prevent drying during the seven-day curing period or until the pavement is constructed.

This page was left blank for future use.



## SECTION 403

### PORTLAND CEMENT/FLY ASH TREATED SUBGRADE

#### 403.1 DESCRIPTION

This work consists of incorporating Portland Cement or Fly ash, as stabilizing agents, into prepared roadway subgrades.

#### 403.2 MATERIALS

##### Fly Ash

Fly ash shall meet requirements of ASTM C-618, Class C, and shall come from a source approved by the Engineer.

##### Portland Cement

Portland cement shall be Type I/II and shall meet the requirements of ASTM C-150.

#### 403.3 SUBGRADE PREPARATION

Prior to the application of cement or fly ash, the subgrade shall be brought to the proper elevation, removing all soft spots as described in Section 401.

The surface of the subgrade shall be scarified to a depth necessary to provide the quantity of material, which when combined with the cement/fly ash, will produce a compacted subgrade of the thickness designated on the plans. The scarified soil shall be processed with approved graders, discs, harrows, or rotary mixers until 75 percent (75%) of the soil, by dry weight, exclusive of gravel or stone, shall pass a No. 4 sieve. The requirement of 75 percent (75%) passing the No. 4 sieve may be waived at the direction of the Engineer for predominately coarse sandy soils, but the Contractor shall still pulverize the soil to the extent that homogenous mixture of soil and cement/fly ash can be obtained. The use of gang plows or blades will be required in this operation to insure that the full depth of material will be loosened from the subgrade and pulverized. The length of roadway scarified and pulverized at any time shall not exceed the length which can be completed in accordance with these specifications in two working days, except by special permission from the Engineer. The soil shall be manipulated and brought to a moisture content of not greater than three percentage (3%) points below the optimum moisture of the soil involved before application of the cement/fly ash.

#### 403.4 APPLICATION

Application rates for cement/fly ash will be determined by the Engineer, consistent with the various types of subgrade soils. Application shall not be performed when the subgrade is frozen, the temperature in the shade is less than 50 degrees Fahrenheit for cement or 40 degrees Fahrenheit for fly ash, or when wind conditions are such that blowing material becomes objectionable to traffic or adjacent property owners. The soil and cement/fly ash mixture shall extend to a depth of six inches (6") and for a distance of eight inches (8") beyond the back of the curb lines of the pavement unless indicated otherwise by the plans or contract.

Either bagged or bulk cement may be used. When bulk cement is used, approved spreading and weighing equipment shall be provided by the Contractor. When bagged cement is used, the

manufacturer's bagged weights shall be accepted to determine the rate of application. Bags shall be placed in a uniform and regular pattern on the subgrade and the frequency of placing shall be determined by rate of application. The bags shall then be opened and the cement spread evenly over the subgrade using a motor grader or other approved method.

Fly ash shall not be applied by the slurry method. The fly ash shall not be placed on wet subgrade or otherwise allowed to become wet during application.

#### **403.5 MIXING AND COMPACTION - CEMENT**

Cement shall be added as previously specified upon completion of the soil preparation. The cement and soil shall be thoroughly mixed prior to addition of any water. The equipment used in all mixing shall be such that a uniform mix for the full depth of the material will be assured. Any mixture of soil and cement that has not been compacted shall not remain undisturbed for more than thirty minutes. Water shall be added to the soil-cement mixture upon completion of the dry mixing by the use of pressure distributors. Each application of water shall be partially mixed to avoid a concentration of water near the surface. The addition of water shall be controlled so that the moisture content of the completed mixture falls inside a range from optimum to five percent (5%) above optimum moisture of the soil-cement mixture. Sufficient water distribution equipment shall be used to insure the continuous application of all water required on the section of roadway being processed within a two-hour period. The mixing of the soil-cement mixture and water shall be done with discs, harrows, blades, plows, and tillers until the full thickness of the material is thoroughly and uniformly mixed.

Compaction shall begin within thirty (30) minutes after the material has been mixed and spread. The full thickness of the material shall be compacted to a density of not less than 95 percent (95%) of standard compaction of the soil-cement mixture as determined by the Engineer. The compaction operation shall be sufficient to compact the section of roadway being processed within a period of two (2) hours after compacting operations begin. Sufficient light blading shall be done during the compaction operations to blade out all irregularities and to insure a smooth finished surface conforming to the plan cross-section. Enough sprinkling shall be done during the compaction operation to insure that the moisture content of the mixture will stay in the required range.

Cement shall be applied only to such an area that all operations from the application of the cement to the final compaction can be continuous, and all compaction and finishing completed within a period of six (6) hours after the beginning of the water application to the mixed soil-cement. When any of the operations after application of the cement are interrupted for a period of more than two (2) hours for any reason, or when the uncompacted soil cement mixture is wetted by rain so that the average moisture content at the time of completing compaction is greater than five percentage (5%) points above the optimum moisture content, the entire section affected shall be reconstructed in accordance with these specifications by the Contractor at his expense.

The surface of the cement-treated base shall be trimmed to the required line and grade by means of equipment which is automatically controlled with regard to both longitudinal and transverse slopes.

The Engineer may waive the use of automatically controlled equipment on narrow widths or areas of irregular dimensions where operation of the automated equipment is impractical.

When required, the surface shall be lightly scarified to loosen any imprints left by the compacting and shaping equipment. The resulting surface then shall be thoroughly rolled with steel-wheel or pneumatic-tired rollers or both.

The surface of the material shall be kept moist during all finishing operations. Surface compaction and finishing of the section being processed shall be done in such a manner as to produce a relatively

smooth, dense surface, essentially free of surface compaction planes, cracks, ridges or loose material. The completed base course shall conform to the grades, lines and typical cross section shown on the plans with compacted and dressed edge slopes and all evidence of laps between the various sections eliminated. With the approval of the Engineer, surface finishing operations may be varied, provided the quality of the work is as outlined above.

Sufficient equipment shall be in operation on the project so that all operations can be carried on in their proper sequence without delay and so that final compaction, rolling and finishing can be completed during daylight hours.

At the end of each day's operations, or in case of construction delays that will cause operations to cease, and at a point where satisfactory construction has been completed, a straight transverse construction joint shall be formed by cutting back into the completed work to form a true vertical face. A protective covering of earth shall be placed on the newly constructed base course for a distance back of the joint required for the turning of equipment used on the following day's work. The thickness of the covering shall be such that the equipment will not mar or damage completed work.

#### **403.6 MIXING AND COMPACTION - FLY ASH**

##### **Mixing**

Mixing of the fly ash with the subgrade soil shall follow application and spreading as a continuous construction operation. Mixing lifts shall not exceed plan lift thickness unless previously approved. Work areas for mixing shall not exceed 5,000 square yards unless otherwise authorized by the Engineer.

The mixing procedure shall be as hereinafter described:

- a) **First Mixing.** The moisture content of the subgrade soil shall not exceed eighty percent (80%) of optimum at the time of first mixing. The soil and fly ash shall be mixed until a uniform mixture is obtained in which all clods and non-aggregate lumps are reduced to a maximum of two and one-half inches (2.5") diameter size. The addition of water will not be permitted during first mixing. First mixing operations shall begin no later than four (4) hours after application of the fly ash.

When deemed necessary by the Engineer, any portion of the work area shall be re-scarified and additional fly ash added to insure adequate soil modification.

The fly ash and soil shall be thoroughly mixed to the satisfaction of the Engineer prior to the beginning of final mixing operations.

- b) **Final Mixing.** After the dry soil and fly ash have been satisfactorily mixed, additions of water shall be made in the final mixing operations to initiate soil-fly ash reaction. The method of mixing shall be an approved procedure utilizing a traveling rotary mixing plant which demonstrates uniform dispersion of fly ash and water throughout the soil materials. The quantity of water necessary for the final mixing operations will vary with the nature of the materials, normally two to five percentage (2-5%) points above the optimum moisture content of the compacted modified soil. Sufficient water in any case shall be added in the final mixing process to insure chemical reaction between the fly ash and soil.

All clods shall be reduced in size by mixing until the soil-fly ash mixture meets the following size requirements when tested with laboratory sieves:

<u>Sieve Size</u>	<u>Percent Passing</u>
1 1/2 inch	100
3/4 inch	50-100

**c) Optional**

The following alternate mixing procedure may be used at the option of the Contractor and with the approval of the Engineer in lieu of the procedure described in the above paragraphs. The moisture content of the soil shall be adjusted to between two (2) and five (5) percentage points above optimum prior to application of any fly ash. Fly ash shall then be applied and mixing shall begin immediately. The soil and fly ash shall be mixed until a uniform mixture is obtained in which all clods and non-aggregate lumps are reduced to a size such that one hundred percent (100%) will pass a one and one-half inch (1 1/2") screen and fifty percent (50%) to one hundred percent (100%) will pass a three quarters inch (3/4") screen. Sufficient water shall be added in this mixing process to insure chemical reaction between the fly ash and water throughout the soil materials. Compaction shall begin immediately after the mixing is completed when this prescribed procedure is used.

**Compaction**

Compaction of the soil-fly ash mixture shall be performed immediately after final mixing, wherein the compaction operation shall be a continuation of the final mixing operation. Each lift of mixed fly ash-soil material shall be compacted full depth to a density of not less than ninety-five percent (95%) of standard compaction of the fly-ash soil material as determined by the Engineer.

The soil-fly ash mixture shall be compacted without delay and before any appreciable loss of mixing moisture occurs. Mixing and compaction operations shall be performed in such a manner that the mixture will be compacted within plus or minus three percentage (3%) points of optimum moisture content. However, when deemed necessary by the Engineer during the course of construction, changes or adjustments in the specified moisture requirements to meet field conditions may be authorized.

Compaction shall continue until the entire depth of the mixture is uniformly compacted. The rate of operation and the number of rollers shall be sufficient to compact uniformly the section of roadway being processed within two (2) hours after introduction of water.

During the early stages of subgrade construction, the Engineer will work closely with the Contractor by reporting compaction test results promptly for each stage of fly ash modified subgrade construction as an aid to the Contractor to establish a construction procedure that will attain the required density within the prescribed two (2) hours.

The material shall be sprinkled and rolled. All irregularities, depressions or weak spots which develop shall be corrected immediately by scarifying the areas affected, adding or removing material as required, and reshaping and recompacting by sprinkling and rolling.

In addition to the requirements specified for density, the full depth of the material shown on the Plans shall be uniformly compacted to the extent necessary to remain firm and stable under construction equipment. After each section is completed, density tests as necessary will be made by the Engineer. If the material fails to meet the density requirements, it shall be reworked as necessary to meet these requirements. Rework shall include the addition of more fly ash at a rate determined by the Engineer. Throughout this entire operation the shape of the course shall be maintained and the surface upon completion shall be smooth and in conformity with the typical sections shown on the Plans and to the established lines and grades. Should the material, due to any reason or cause, lose the required stability,

density or finish before the next course is placed or the work is accepted it shall be recompacted and refinished at the sole expense of the Contractor.

#### **403.7 CURING AND PROTECTION**

The completed cement/fly ash treated subgrade shall be protected against loss of moisture for a period of seven (7) days. The curing time may be reduced to a minimum period of three (3) days only when approved by the Engineer and as further determined by individual project conditions. The completed cement/fly ash treated subgrade shall be protected against loss of moisture by covering with an approved moisture barrier such as moist burlap or polyethylene sheet, or at the option of the Contractor and at his own expense, an application of emulsified asphalt may be applied, using approved pressure-distributing equipment immediately after the completion of the finishing operations. The asphalt emulsion shall contain not less than forty percent (40%) of asphalt and shall preferably be of the quick-breaking type of emulsion.

Immediately prior to the application of the bituminous curing membrane, however, the surface shall be thoroughly wetted by means of approved pressure-distributing equipment. No free water shall remain on the surface when the bituminous material is applied. The Contractor shall keep all traffic off the cement/fly ash-treated subgrade after the curing medium has been applied and until the base has cured for the specified length of time.

The Contractor shall be required to maintain, at his own expense, the entire roadway within the limits of the improvement, in good condition, satisfactory to the Engineer, from the time he first starts work until all work has been completed. Maintenance shall include immediate repair of any defects that may occur either before or after the cement/fly ash is applied to the subgrade soil.

Cement/fly ash treated subgrades shall be constructed to elevations such that it will not be necessary to cut or trim in excess of one inch (1") of material off the subgrade.

This page was left blank for future use.

## SECTION 404

### GEOGRID REINFORCED AGGREGATE BASE

#### 404.1 CRUSHED ROCK BASE FOR CONCRETE PAVER SURFACE

Where the plans and typical sections call for crushed rock base under concrete paver surfaces, the materials used shall be crushed concrete meeting the specifications for size and gradation for crushed rock base. Any additional costs for crushed concrete or for extra thickness as shown on the details will be incidental to the bid item.

#### 404.2 MATERIALS

##### General

Materials to be used for geogrid reinforced base construction shall consist of virgin crushed stone, recycled Portland cement concrete, or Reclaimed Asphalt Pavement (RAP).

##### Stone/Concrete Aggregate

##### 1) Gradation

<u>Sieve Size</u>	<u>Percent % Retained (by dry weight)</u>
2-1/2"	0
3/4"	20-60
#4	50-80
#40	80-94
#200	90-98

##### 2) Durability

Base material quality shall conform to the requirements specified by the KDOT Subsection 1102 for Durability Class 1.

##### 3) Absorption

All virgin base material shall have a maximum absorption of four percent (4%).

##### Recycled Asphalt Pavement (RAP)

Recycled Asphalt Pavement (RAP) shall be free of detrimental quantities of organic, non-granular soils and deleterious materials.

The RAP sub-base shall be a six-inch minimum deep lift of 100 percent pulverized asphalt concrete compacted to at least ninety-five percent (95%) of Standard Proctor with a moisture content equal to or greater than optimum. A moisture-density relationship may be prepared in advance with RAP that will be delivered to the project.

The maximum size of the RAP particles shall be 1-1/2 times the maximum aggregate size in the RAP material.

RAP sub-base shall be compacted and smoothed with a steel-faced roller prior to placement of asphalt. Tack coat will not be applied to RAP.

### **Biaxial Geogrid**

The geogrid shall be a regular grid structure formed by biaxially drawing a continuous sheet of select polypropylene material and shall have aperture geometry and rib and junction cross-sections sufficient to permit significant mechanical interlock with the material being reinforced. The geogrid shall maintain its reinforcement and interlock capabilities under repeated dynamic loads while in service and shall also be resistant to ultraviolet degradation, to damage under normal construction practices and to all forms of biological or chemical degradation normally encountered in the material being reinforced.

The geogrid shall be BX100 by Tensar Corporation, or approved equal, and shall also conform to the following requirements.

<b>PROPERTY</b>	<b>TEST METHOD</b>	<b>UNITS</b>	<b>VALUE</b>
<u>Interlock</u>			
= aperture size <sup>1</sup>	I.D. Calipered <sup>2</sup>		
= MD	in	1.0 (nom)	
= CMD	in	1.3 (nom)	
= open area	CDE Method <sup>3</sup>	%	70 (min)
= thickness	ASTM D 1777-64		
= ribs		in	0.03 (nom)
= junctions		in	0.11 (nom)
<u>Reinforcement</u>			
= flexural rigidity	ASTM D1388-64 <sup>4</sup>	mg-cm	250,000 (min)
= tensile			
- modulus	GRI GG1-87 <sup>5</sup>	lb/ft	13,500 (min)
- @ 2% strain	GRI GG1-87 <sup>5</sup>	lb/ft	270 (min)
- @ 5% strain	GRI GG1-87 <sup>5</sup>	lb/ft	540 (min)
- ultimate strength	GRI GG1-87 <sup>5</sup>	lb/ft	850 (min)
= junctions	GRI GG2-87 <sup>6</sup>		
= strength		lb/ft	750 (min)
= efficiency		%	90 (min)
<u>Material</u>			
= polypropylene	ASTM D 4101 Group 1/Class 1/Grade 2	%	98 (min)
= carbon black	ASTM 4218	%	0.5 (min)
<u>Minimum Dimensions &amp; Weights</u>			
= roll length		ft	164
= roll width		ft	9.8 & 13.1
= roll weight		lb	71 & 95

---

#### Notes:

1. MD dimension is along roll length. CMD dimension is across roll width.
2. Maximum inside dimension in each principal direction measured by calipers.
3. Percent open area measured without magnification by Corps of Engineers method as specified in CW 02215 Civil Works Construction Guide, November 1977.
4. ASTM D 1388-64 modified to account for wide specimen testing as described in Tensar test method TTM-5.0 "Stiffness of Geosynthetics".
5. Secant modulus at 2% elongation measured by Geosynthetic Research Institute test method GG1-87 "Geogrid Tensile Strength". No offset allowances are made in calculating secant modulus.
6. Geogrid junction strength and junction efficiency measured by Geosynthetic Research Institute test method GG2-87 "Geogrid Junction Strength".



### 404.3 CONSTRUCTION REQUIREMENTS

#### Subgrade Preparation

Prior to placement of the geogrids, the subgrade shall be prepared as described in Section 401.

#### Placing and Overlapping Geogrids

Place geogrids in position and roll out over the prepared subgrade. Geogrid should be cut to conform to manhole covers or other protrusions. Geogrid should be cut and overlapped as necessary to accommodate curves. Pin overlaps to secure against separation and to provide anchorage. If two rolls are to be placed side by side, or end to end, overlap them as noted in Table 1.

**Table I: Recommended Overlaps**

<u>Soil Type</u>	<u>CBR</u>	<u>Grid Overlap</u>
Firm	> 2	1'
Soft Ground	1-2	2'
Very Soft Ground	< 1	3'

Overlap geogrids in the direction fill will be spread. Over very soft ground, wire, plastic ties or hog rings can be used on five to twenty-foot spacings as necessary to secure the overlaps.

#### Tensioning and Pinning

Pin beginning of roll to the ground with six-inch (6") "U" staples or other approved fastener. Pin at edges, overlaps, and center of roll width. Over soft ground it may only be necessary to secure the end with stakes, rocks, or fill.

Pull geogrids tight by hand to take up all slack.

- a) **Firm Ground.** Anchor geogrid to the ground at edges, including overlaps, and in center of roll on thirty foot (30') intervals along the roll length.
- b) **Soft Ground.** Anchor only the roll ends. The geogrids will conform to the ground surface as the fill material is dumped.

Anchor the terminal ends of the roll. If the overlap is required for advancing rolls, overlap as noted previously and anchor at the overlap.

#### Dumping and Spreading

- a) **Soft Subgrade.** Back Dump or End Dump and Spread. Thin fill lifts over very soft subgrades may not be sufficient to support loads of fill and heavy equipment. Low ground pressure tractors and low tire pressures (less than 4 psi) are recommended for hauling and spreading fill over these conditions. Do not operate equipment directly on the grid. Insure at least four inches (4") of fill is between the grid and vehicle.

Back dump specified fill onto the geogrid where subgrade is most stable. Spread the fill material over the geogrid out toward the softer subgrade.

Grade fill to the specified thickness. Raise the blade gradually as the fill is pushed out over the grid. This causes much of the fill to roll out onto the grid and reduce stresses on the subgrade.

Back dump subsequent loads onto the leveled fill and advance forward by spreading with a dozer.

- b) **Firm Subgrade.** Dump while driving over. Adequate anchoring is required in this case to prevent haul traffic from pushing or shifting grid out of position on the ground.

Rubber tire trucks (end and belly dumps) can drive over the grid at very slow speeds, less than 5 mph, and dump fill as they do. Avoid turning and sudden stops. Do not drive tracked vehicles directly on the grid. Ensure at least four inches (4") of fill is between the grid and tracks.

Back Dumping can be employed over firm ground as described for soft ground conditions.

Grade fill material to desired thickness. Raise the blade while leveling fill.

Crown fill during the grading process to assure rainfall runoff and prevent fill saturation.

### **Compaction**

Compact fill to project specifications after it is graded smooth and before it is open to truck traffic. Inadequate compaction will result in surface rutting under wheel loads. This reduces the total thickness of the fill and increases stress on the subgrade. **Note:** Compaction equipment should be appropriate for the type of fill used and subgrade conditions that exist. Do not use vibratory compactor on fill over very soft saturated subgrades. It may cause a "quick" condition resulting in rapid subgrade strength loss.

### **Repairs**

Should the geogrid be damaged during or after installation, repair by patching.

Remove fill from the surface of the grid at the damaged area and three feet (3') around in all directions.

Place a geogrid patch of appropriate dimensions to cover damaged area and extending three feet beyond in all directions.

Replace fill and compact.

### **Finish**

Rock base is to be compacted and smoothed with a steel faced roller prior to placement of asphalt or concrete pavement. Tack coat will not be applied to rock base.

## SECTION 405

### ASPHALTIC CONCRETE PAVEMENT

#### 405.1 DESCRIPTION

This item shall consist of leveling, surface and/or base courses and curbs placed upon the previously prepared base or subgrade in accordance with these specifications to the compacted thickness and design shown on the plans or ordered in writing by the Engineer.

#### 405.2 MATERIALS AND MANUFACTURE:

##### Aggregate

The approval of sources of supply for stone, gravel, sand, and mineral filler supplement to be used in asphaltic mixtures shall be obtained from the Engineer prior to delivery to the project and samples of each aggregate or mineral filler shall be submitted for testing as directed by the Engineer. All test procedures shall be conducted in accordance with the latest standards or tentative standards of the American Society for Testing and Materials. Individual aggregates having more than ten percent (10%) retained on the No. 8 sieve shall have a percent of wear of not more than forty percent (40%) when tested by the Los Angeles Abrasion Test Method. Individual aggregates having more than ten percent (10%) retained on the No. 8 sieve shall have a loss of not more than fifteen percent (15%) when tested by the Sodium Sulfate Method as specified in the latest revision of ASTM C-88. That portion of individual aggregates retained on No. 30 sieve shall have a maximum absorption of four percent (4%). Individual aggregates used in surface course mixes which have more than ten percent (10%) retained on the No. 8 sieve shall have a loss of not more than eighteen percent (18%) when tested by the Magnesium Sulfate Method as specified in ASTM C-88.

All aggregates and mineral filler supplements to be used in asphaltic mixtures shall be free from alkali, acids, organic matter, or injurious quantities of other foreign substances. Other deleterious substances in each individual aggregate or mineral filler supplement shall not exceed the following percentages by weight:

<u>Substance</u>	<u>Max. %</u>
Sticks (wet)	0.1%
Shale, shale like, or soft friable material, singly or in combination	3.0%
Coal	0.5%

##### a) **Crushed Rock**

Crushed rock shall be produced from durable rock. The crushed rock shall have a percent of wear of not more than forty percent (40%) when tested by the Los Angeles Abrasion Test Method. Crushed rock shall be of uniform quality throughout, without an excess of flat or elongated pieces and it shall be clean and free from dust such that not more than four percent (4%) of the material will pass the No. 200 sieve.

##### b) **Crushed Gravel**

Crushed gravel shall be produced by crushing siliceous or calcareous gravel. At least ninety percent (90%) of the particles retained on the No. 4 sieve shall have one or more fractured faces to be considered as crushed gravel. The screenings resulting from the crushing of gravel will not be considered as crushed aggregate. Crushed gravel shall be clean and free from dust such that not more than four percent (4%) of the material will pass the No. 200 sieve. Crushed gravel having more than ten percent (10%) retained on the No. 8 sieve shall have a percent of wear of

not more than forty (40%) when tested by the Los Angeles Abrasion Test Method.

**c) Sand-gravel**

Sand-gravel shall be a mixture of natural sand and gravel formed by the disintegration of siliceous and/or calcareous rocks. Natural sand shall consist of particles of aggregate resulting from the natural disintegration of siliceous and/or calcareous rocks. Manufactured sand shall be produced by crushing predominately siliceous sand and gravel. Sand-gravel having more than ten percent (10%) retained on the No. 8 sieve shall have a percent of wear of not more than forty (40%) when tested by the Los Angeles Abrasion Test Method. That portion of sand-gravel passing the No. 40 sieve shall have a plasticity index of not more than 6. Sand-gravel shall be graded such that not more than twenty percent (20%) will pass a No. 200 sieve.

**d) Chat**

Chat shall consist of mine run or screened tailings produced during the milling of lead and zinc ores in the mining district of Southeast Kansas, Southwest Missouri, and Northeast Oklahoma. Chat shall be graded such that when mixed with the other aggregates the combined gradation will conform to the specified requirements.

**e) Screenings**

Screenings shall be produced by crushing aggregates that meet the quality requirements for crushed rock. The gradation shall be such that not more than two percent (2%) will be retained on the three eighths inch (3/8") sieve and not more than forty percent (40%) will pass the No. 200 sieve. That portion of screenings passing the No. 40 sieve shall have a plasticity index of not greater than 6.

**f) Mineral Filler**

Mineral filler is defined as that portion in the final combined mix that is finer than the No. 200 sieve. Material to supplement the mineral filler in the coarser aggregates, when required, shall consist of Portland cement, pulverized limestone, hydrated lime, or processed and dewatered chat sludge. All mineral filler supplements shall meet with the approval of the Engineer. Mineral filler supplements shall be free from cemented lumps and must be easily pulverized. The blending of two or more materials to produce a mineral filler supplement will not be permitted. Material to be used as a mineral filler supplement shall have a plasticity index of not greater than 6. Hydrated lime or Portland cement to be used as a mineral filler supplement shall conform to the same requirements as specified for these materials in the specifications for treated subgrade, Sections 402 and 403. Pulverized limestone and processed chat sludge shall be graded such that not more than forty percent (40%) of the material will be retained on the No. 200 sieve when used as a mineral filler supplement. Silt will have a minimum of fifty percent (50%) passing the 200 sieve.

**Asphalt Cement**

Asphalt cement shall be of uniform consistency, free from water to the extent that it will not foam when heated to three hundred fifty degrees (350°) F., and it shall meet the following requirements for physical and chemical properties:

**Penetration Graded Asphalt Cement**

- |    |   |          |
|----|---|----------|
| 1. | Flash point (COC)° F.   | 450+     |
| 2. | Penetration, 77° F., 100g., 5 secs.   | 60 to 70 |
| 3. | Ductility at 77° F., 5 cm./min., cm   | 100+     |
| 4. | Loss at 325° F., 5 hours, percent   | 1.0-     |
| 5. | Penetration of residue at 77° F., 100g., 5 secs.,<br>as compared to penetration before heating, percent | 75+      |
| 6. | Solubility, percent   | 99+      |

**Viscosity Graded Asphalt Cement**

Viscosity, 140° F., poises	1600 min. - 2400 max.
Viscosity, 275° F., centistokes	300 min.
Penetration, 77°F., 100 g., 5 sec.	60 min.
Flash Point (COC), °F	460 min.
Solubility, percent	99.0 min.
Loss on heating, thin-film oven test	0.5% max.

**Tests on Residue from Thin-Film Oven Test**

Viscosity, 140° F., poises	8000 max.
Ductility, 77° F., 5 cm. min., cm	50 min.

Penetration graded asphalt cement may be changed during cold weather construction on residential streets from a 60-70 penetration at seventy-seven degrees (77°) F., 100 grams, 5 seconds to an 85-100 penetration at seventy-seven degrees (77°) F., 100 grams, 5 seconds when requested by the Contractor and approved by the Engineer. Viscosity graded asphalt cement may be changed during cold weather construction on residential streets from a viscosity of 2000 ±400 poises at 140°F. to a viscosity of 1000 ±200 poises at 140°F. when requested by the Contractor and approved by the Engineer. No additional compensation will be made for this change in grade of asphalt cement. Viscosity graded asphalt cements shall not be mixed with penetration graded asphalt cements.

All asphalt cement used on any one project shall be penetration graded or viscosity graded at the Contractor's option. The Contractor will be permitted to change asphalt grades on any one project only in the event of unavailability of asphalt from his initial source and with the provision that his storage tanks are drained prior to changing from one type of grading to the other type of grading. Asphalt mixes shall be redesigned whenever a change in asphalt grading is permitted.

**Polymer Modified Asphalt Cement**

The material shall consist of an asphalt cement to which a styrenebutadiene polymer has been added. The polymer modified asphalt cement shall be smooth, homogeneous and comply with the following requirements:

a)	Property	Type 1C	Type 1D
	Penetration @ 77°F, 100g, 5 sec.:	Min 50	40
		Max 75	75
	Penetration @ 39.2°F, 200g, 60 sec.:	Min 25	25
	Viscosity, @ 140°F <sup>1</sup> , Poise:	Min 5000	5000
	Viscosity, @ 275°F, cSt:	Max 2000	2000
	Ring & Ball Softening Point, °F:	Min 130	140
	Flash Point, °F:	Min 450	450
	Solubility in Trichloroethylene <sup>2</sup> , %	Min 99.0	99.0
	Separation, <sup>3</sup> Ring & Ball difference, °F:	4	4
b)	Test for Elasticity (after aging)		
	Elastic Recovery <sup>4</sup> , 77°F, %	Min45	50
c)	Tests on Residue from Rolling Thin-film Oven Test		
	Penetration @ 39.2°F, 200g, 60 sec.:	Min13	13

---

1 Solubility of original asphalt by ASTM D2042

- 2 Stiffer mix generally used in intersections to prevent rutting.
- 3 Procedure attached
- 4 Procedure attached

d) Separation Test for Type I Polymer Modified Asphalt:

### **Scope**

The separation of polymer from asphalt during hot storage is evaluated by comparing the ring and ball softening point of the top and bottom samples taken from a conditioned sealed tube of polymer modified asphalt. The conditioning consists of placing a sealed tube of polymer modified asphalt in a vertical position in a 325°F oven for a 48-hour period.

### **Referenced Documents**

ASTM D36: Softening Point of Bitumen (Ring and Ball Apparatus)

ASTM E11: Specifications for Wire Cloth Sieves for Testing Purposes

### **Apparatus**

**Aluminum Tubes** - 1 inch diameter by 5-1/2 inch length blind aluminum tubes. Used to hold the test sample during the conditioning.

**Oven** - An oven capable of maintaining  $325 \pm 10^\circ\text{F}$

**Freezer** - A freezer capable of maintaining  $20 \pm 10^\circ\text{F}$

**Rack** - A rack capable of supporting the aluminum tubes in a vertical position in the oven and freezer.

**Spatula and Hammer** - The spatula must be rigid and sharp to allow cutting of the tube containing the sample when at a low temperature.

### **Procedure**

Place the empty tube with sealed end down in the rack. Carefully heat the sample until sufficiently fluid to pour. Care should be taken to avoid localized overheating. Strain the melted sample through a No. 50 sieve conforming to ASTM E11. After thorough stirring, pour 50.0 grams into the vertically held tube. Fold the excess tube over two times and crimp and seal.

Place the rack containing the sealed tubes in a  $325 \pm 10^\circ\text{F}$  oven. Allow the tubes to stand undisturbed in the oven for a period of  $48 \pm$  one hour. At the end of the heating period, remove the rack from the oven and immediately place in the freezer at  $20 \pm 10^\circ\text{F}$  taking care to keep the tubes in a vertical position at all times. Leave the tubes in the freezer for a minimum of four hours to completely solidify the sample.

Upon removing the tube from the freezer, place the tube on a flat surface. With the spatula and hammer, cut the tube into three equal length portions. Place the beakers in a  $325 \pm 10^\circ\text{F}$  oven until sufficiently fluid to remove the pieces of aluminum tube.

After a thorough stirring, pour the top and bottom samples into appropriately marked rings for the ring and ball softening point test. Prepare the rings and apparatus as described in ASTM D36<sup>2</sup>. The top and bottom sample from the same tube should be tested at the same time in the softening point test.

---

Aluminum tubes may be obtained from Sheffield Industries, P.O. Box 351, New London, CT 06320, 203/442-4451. Observations have been reported regarding leakage of asphalt from the bottom of these tubes during the conditioning period.

- 1 Other tubes may be required if this leakage is significant
- 2 Other physical and chemical residue tests may be run at this time, if desired.

Report:

Record the softening point of the top and bottom portions of the sample. Duplicate separation tests should be run.

d. Elastic Recovery Test

Scope:

The elastic recovery of a polymer modified asphalt cement is evaluated by the percentage of recoverable strain measured after elongation during a conventional ductility test. Unless otherwise specified, the test shall be made at a temperature of 77°F ± 0.9°F (25 ± 0.5°C) and with a speed of 5 cm/min ± 5.0%.

Referenced Documents:

ASTM D113: Ductility of Bituminous Materials

ASTM E11: Specifications for Wire Cloth Sieves for Testing Purposes

Apparatus:

**Mold** - The mold shall be similar in design to that described for use in the ductility test (ASTM D113), Figure 1, except that the sides of the mold assembly, parts a and a' shall have straight sides producing a test specimen with cross-sectional area of 1 cm<sup>2</sup>

**Water Bath** - The water bath shall be maintained at the specified test temperature, varying not more than 0.18°F (0.1°C) from this temperature. The volume of water shall be not less than 10 cm and shall be supported on a perforated shelf not less than 5 cm from the bottom of the bath.

**Testing Machine** - For pulling the briquet of bituminous material apart, any apparatus may be used which is so constructed that the specimen will be continuously immersed in water as specified while the two clips are pulled apart at a uniform speed without undue vibration.

**Thermometer** - An ASTM 63°C or 63°F thermometer shall be used.

**Scissors** - Any type of conventional scissors capable cutting polymer modified asphalt at the test temperature.

**Procedure:** Prepare test specimens and condition as prescribed by ASTM D113.

Elongate the test specimen at the specified rate to a deformation of 10 cm.

Immediately cut the test specimen into two halves at the midpoint using the scissors. Keep the test specimen in the water bath in an undisturbed condition for one hour. After the one hour time period, move the elongated half of the test specimen back into position near the fixed half of the test specimen so the two pieces of polymer modified asphalt just touch. Record the length of the test specimen as X.

**Report:** Calculate the percent recovery by the following procedure:

$$\text{Recovery, \%} = \frac{10 - X}{10} \times 100$$

**Composition of Asphaltic Mixtures**

Aggregates, mineral filler and asphalt shall comply with the requirements, as stated previously in this subsection. The Contractor shall submit to the Engineer before December 31 of each calendar year a complete listing of Individual Aggregate Sieve Analysis, Mix Combination Sieve Analysis and any other pertinent data on the mixes to be used during the following calendar year. The Engineer may use the submitted design in whole or in part, at his discretion. The mix design

shall be adjusted as necessary when a change in the source of materials is approved. Any mix design that proves to be unsatisfactory shall be adjusted by the Engineer. There shall not be less than three percent (3%) or more than twenty-five (25%) of material between any two successive sieves in the following series: No. 4, 8, 16, 30 and 50. The requirements for percent retained on the No. 200 sieve (dry screen) will be waived, provided the plasticity index of the mineral filler is four (4) or less.

Salvaged hot mix asphaltic materials may be recycled and combined with new materials to produce asphaltic base course and surface mixtures for use in construction of such base courses and surface courses as required by plans. The combination of salvaged hot mix asphaltic material with new materials shall not exceed twenty-five percent (25%) for base course mixtures or fifteen percent (15%) for surface course mixtures. All base course mixtures containing recycled asphaltic material shall conform to the standard specification requirements for a BC-1 type mix, unless otherwise noted on the plans. All surface course mixtures containing recycled asphaltic material shall conform to the standard specification requirements for an SC-1 type mix, unless otherwise noted on the plans.

**Gradation Requirements**

<b>Mineral Aggregates Percentage by Weight Retained</b>			
<b>Sieve Size</b>	<b>Base Course BC-I</b>	<b>Surface Course SC-I</b>	<b>Surface Course BM-IB</b>
2-1/2"			
1-1/2"			
1"	0		
3/4"	0-12	0	0
1/2"		0-8	0-10
3/8"	2-35	0-18	12-26
#4		18-39	39-56
#8	30-66	35-53	60-76
#10			
#16		56-68	72-87
#20			
#30	60-82	60-80	79-92
#40			
#50		70-88	84-95
#80			
#100		80-93	88-98
#200	89-96	90-95	92-98
P-200	4-11	5-10	2-8

The combined material for asphalt surface course, SC-I, shall contain not less than 47 percent crushed material, including the material passing the No. 200 sieve.

The combined material for asphalt surface course, BM-IB, shall contain not less than 75 percent crushed material, including the material passing the No. 200 sieve. In addition, course aggregate (#4+) used in BM-IB shall have a maximum absorption of two percent.



### **Design Requirements**

All asphalt mixtures shall conform to the following Marshall requirements when tested in accordance with the latest revision of ASTM D-1559.

<b>Mix Type</b>	<b>BC-I</b>	<b>SC-I</b>	<b>BM-IB</b>
Min stability	1000	1600	1800
Voids (%)	3-7	3-5	3-5
VFA (%)	70 min.	70 min.	68-78

BM-IB requirements shall be for a 75-blow Marshall.

### **405.3 PAVING PLANT**

All plants used by the Contractor for the preparation of asphalt paving mixtures shall conform to the applicable sections of the KDOT Standard Specifications unless specified otherwise. All bins used in storing mixed asphalt material shall be completely enclosed. All elevators used to handle mixed asphalt materials during periods of adverse weather conditions shall be completely enclosed. Adverse weather conditions shall be defined either as rainy or foggy weather, prevailing temperatures of less than sixty degrees (60°) F., or gusting and prevailing winds over twenty (20) miles per hour.

The Contractor shall have the option, with the approval of the Engineer, to operate the asphalt plant without screening the coarse and fine aggregates into separate bins. The basic concepts of this method of operation are to remove all plant screens, with the exception of the scalping screen, and to test and accept each individual aggregate prior to entering the drier. Permission to continue under this option may be rescinded upon failure to maintain acceptable production. All methods of plant operation without screens shall conform to applicable sections of the latest edition of the KDOT Standard Specifications, except that the material produced will meet the requirements as set out in these Specifications.

Asphalt paving mixtures may be prepared by using a drum mix type asphalt plant when approved by the Engineer. The approval of and continued use of a drum mix type asphalt plant shall be contingent upon its ability to proportion and mix satisfactorily the required materials in accordance with the specifications such that the finished work will be equal to the work produced as if accepted standard methods had been used.

### **405.4 PAVING PLANT OPERATION**

**Sand and Stone Storage.** The different kinds of sand and stone used shall be kept separate, using such provisions as deemed necessary by the engineer to keep them from becoming mixed.

All aggregates for surface mixture shall be delivered to a revolving drier. The aggregates shall be heated to a temperature of between 275 degrees F. and 350 degrees F. The aggregate shall then be weighed in accordance with the approved mix. Each batch shall be mixed by first charging the mixer with the coarse and fine aggregate along with the mineral filler and thoroughly mixed, then the asphalt cement shall be added and the mixing continued for at least 45 seconds or longer if necessary to produce a homogenous mixture in which all particles of the aggregate are uniformly coated.

The asphalt cement shall be delivered to the surface mixture at a temperature of 275 degrees F. to 350 degrees F.

The paving plant operation shall conform to the requirements of applicable sections of the latest edition of the KDOT Standard Specifications when plant operations without screening the coarse and fine aggregates into separate bins is permitted.

When the Engineer has approved the use of a drum mix type asphalt plant the sections in these specifications which do not conform to this method shall not be applicable. Approval of and continued use of a drum type asphalt plant shall be contingent upon the results obtained in the completed work.

The Contractor shall give to the Engineer notice of intent to mix and place asphalt materials as far in advance as is possible and the minimum time for such notification shall be four hours. Asphalt materials shall be mixed only when the City's inspector is at the plant site, unless approved otherwise by the Engineer. Mixed asphalt material that has been stored over night shall not be used unless written permission is given by the Engineer.

#### **405.5 CONSTRUCTION REQUIREMENTS**

Equipment used in the construction of asphalt pavements such as hauling equipment, bituminous pavers, heating equipment, bitumen distributors, compacting equipment, and weighing equipment shall conform to the applicable sections of the latest edition of the KDOT Standard Specifications.

#### **405.6 PREPARATION OF THE BASE**

##### **Prepared Subgrade or Geogrid Aggregate Base**

After the road bed has been prepared, as described in Sections 401-404, it shall be maintained during asphalt placement until completely covered. It shall be the Contractor's sole responsibility to maintain the subgrade as prepared, and any defect which may develop shall be corrected at his expense.

##### **Existing Bituminous Surface**

When the surface is constructed on an existing bituminous surface, the surface shall be cleaned of all foreign material and broomed free of dust. In addition, any loose, broken or shattered bituminous material along the edges of the existing surface shall be removed and the exposed subgrade and a sufficient width of the shoulder adjacent to the edge of the existing surface to receive the new bituminous mixture shall be shaped, bladed and broomed to provide a uniform trim subgrade for the new surface course.

The existing mat, base, or subgrade shall be removed through broken, shattered, or unstable areas as shown on the Plans or designated by the Engineer. The areas shall be excavated to a depth directed by the Engineer, and refilled with bituminous base mixture.

##### **Concrete or Brick Pavement**

If the existing surface is concrete pavement or brick pavement, the pavement shall be cleaned of dirt, bituminous material and other foreign material, as directed by the Engineer. Bituminous material such as crack filler or joint material in expansion joints or cracks shall be removed to a depth of at least two inches (2") when specified by the Engineer. The joints and cracks shall then be refilled with surface course material and compacted. Wide longitudinal or diagonal cracks caused by the transverse movement of portions of the pavement shall be cleaned for their full depth and back filled with surface course material and the material compacted is not to exceed three-inch (3") layers by means of mechanical or hand tampers equipped with special tamping heads. Crack cleaning and filling shall be done as far in advance of the leveling course as is practicable.

##### **Tack Coat**

Prior to the placing of the mixture, when designated by the Engineer, a tack coat shall be applied to the existing surface. The type of asphalt used shall be emulsified asphalt (CSS-1h), or (SS-1h), and the rate of application shall be designated by the Engineer, except as set forth below.

Tack coat shall be diluted in the proportion of 50 percent water and 50 percent emulsion and applied at

the rate of 0.05 to 0.10 gallons per square yard. Application shall be made in advance of subsequent construction as ordered by the Engineer.

Tack coat shall be applied by distributor trucks designed, equipped, and maintained to provide uniform coverage at the designated application rate. Hand spray by means of hose or bar through a gear pump or air tank shall be acceptable for resurface work, corners or tacking or vertical edges. Care shall be taken to provide uniform coverage. Equipment that performs unsatisfactorily shall be removed from the job.

#### **405.7 PLACING REQUIREMENTS**

##### **General**

The bituminous mixture shall be spread and finished reasonably true to crown and grade by the automatically controlled bituminous paver. Bituminous mixtures may be spread and finished by hand methods only where machine methods are impractical as determined by the Engineer.

The automatically controlled paver shall spread the bituminous mixtures without tearing the surface and shall strike a finish that is smooth, true to cross section, uniform in density and texture and free from hollows, transverse corrugations and other irregularities.

The paver shall be operated at a speed which will give the best results for the type of paver being used and which coordinates satisfactorily with the rate of delivery of the mixture to the paver so as to provide a uniform rate of placement without undue intermittent operation of the paver.

All mixed material shall be delivered to the paver in time to permit completion of spreading, finishing and compaction of the mixture during daylight hours. Night time work on projects not open to traffic may be permitted when ample lighting and other satisfactory measures are provided.

The longitudinal joints in successive courses shall be offset not less than twelve inches (12"). The width of the surface of the top course placements shall conform to traffic lane edges when possible.

Bituminous mixtures, except on leveling courses, shall be spread in a placement thickness so that after rolling the nominal thickness of the compacted mat will not in general exceed the following, unless otherwise specified by the Engineer:

**Surface Course**  
2"

**Intermediate**  
4"

**On fresh subgrade**  
4"

The maximum thickness for lifts may be increased when such increase is more adaptable to total pavement thickness and when in the opinion of the Engineer, it is not detrimental to placement and rolling conditions. The Engineer may adjust lift thickness in order to obtain the most efficient combination of aggregate type, laydown equipment, mixture characteristics, temperatures and rolling equipment to produce the required density and surface characteristics.

##### **Established Grade**

The Engineer will make the survey required for the reference grade. The Contractor shall erect and maintain a reference string line and operate the paver to conform to the string line for the initial lift and/or any lifts if specified by the Engineer.

If automatic profile road building type equipment is used to prepare the subgrade, the requirements for an erected reference string line may be waived.

The Contractor shall furnish and maintain an approved mobile string line for all lifts not laid with the

erected string line, and operate the paver to conform to that string line. The erected string line shall be erected parallel to the reference grade, and the bituminous mixture shall be spread at a constant elevation above, below or at the string line elevation as directed.

The use of the automatically controlled bituminous paver to provide both longitudinal and transverse control shall include the furnishing and maintaining of a string line, whether it be erected or mobile, by the Contractor. The longitudinal and transverse controls shall operate independent of each other to the extent that the surface of the bituminous mixture will reasonably conform to the string line and will be reasonably uniform in cross-section or crown.

### **Machine Spreading**

On the initial traffic lane paving operation, the asphaltic mixture shall be spread with the bituminous paver to grade line constant to the Reference String Line as required.

The erection and maintenance of the Reference String Line shall be so coordinated that the string will be taut and free from sags at the time it is in use as a guide for the paver.

On second and subsequent lay-downs, the asphaltic mixture shall be spread as described for the initial lay-down except that the spreading of the asphalt shall conform to the motion of the Mobile String Line.

The Mobile String Line or equivalent shall be used as the reference guide on all paving operations except when the Reference String Line is used or other provisions are made and approved by the Engineer.

On the new construction where paving starts on fresh earth subgrade, the survey may be delayed to the surface of the first course and the use of the Reference Grade Line may be delayed to the first lay-down operation of the second course.

If the existing surface is of acceptable centerline grade as determined by the Engineer from the profile survey, the Engineer may permit the use of the mobile string line for all lifts.

If the automatic longitudinal and transverse controls breakdown, the Engineer may permit the paver to operate during the next three (3) calendar days without the automatic controls to allow time for repair, but it shall not operate on a lift that was laid without automatic controls or if the Plans require only one (1) or two (2) lifts. The initial lift shall not be laid without automatic controls.

The use of the automatically controlled paver may be waived on irregular sections or other sections as designated.

### **Spreading and Surface Tolerances**

The Engineer shall make checks and adjustments as indicated to maintain the rate of spreading within the required calculated weight per unit of area so as to produce a compacted lift thickness in substantial conformity to the design or specified thickness.

Where leveling courses or variable depth courses are specified, the rate of spreading shall be at rates in accordance with the intent of the Plans or as directed by the Engineer.

The surface will be tested by the Engineer using a ten-foot (10') straight edge at selected locations at the Engineer's discretion. The variation of the surface from the testing edge of the straight edge between any two (2) contacts with the surface shall not exceed one-fourth inch (1/4"). All necessary corrections will be at the expense of the Contractor.

### **Placing Temperature**

All asphaltic surface course mixtures shall be delivered to the place of construction within a temperature range of between two hundred sixty degrees (260°) F. and three hundred thirty-five degrees (335°)F. Asphaltic base mixtures shall be delivered to the place of construction within a temperature range of between two hundred twenty degrees (220°) F. and three hundred thirty-five (335°) F. The temperature of the asphaltic mixtures shall be regulated within these limits in accordance with the workability of the mix and the weather conditions. The temperature of the asphaltic materials shall be maintained at the above indicated maximum temperature when hand spreading and raking of the material is required.

#### **Weather Limitations for Placing Asphaltic Mixtures**

Asphaltic mixtures shall not be placed on any wet or frozen surface or when the weather conditions otherwise are detrimental to the proper handling or finishing of such mixtures. Asphaltic mixtures shall not be placed when the air temperature as measured in the shade is less than 40°F. Asphaltic base course material with thicknesses of three inches (3") or more may be placed when the air temperature as measured in the shade is 30°F. or above with the approval of the Engineer if density and Marshall requirements can be obtained.

### **405.8 COMPACTION OF MIXTURES**

#### **Equipment**

After spreading and strike-off and as soon as the temperature and mix conditions permit the compacting to be performed without excess shoving or tearing, the mixture shall be thoroughly and uniformly compacted.

Rollers shall be self-propelled and shall be in good condition, capable of reversing without backlash, and shall be operated at speeds slow enough to avoid displacement of the bituminous mixture. The number and weight of rollers shall be sufficient to compact the mixture to the required density while it is still in a workable condition. The use of equipment which results in excessive crushing of the aggregate will not be permitted. A minimum of two (2) rollers, one (1) steel wheel and one (1) pneumatic tire type, shall be used with each spreading operation unless otherwise specified by the Engineer.

Other approved compaction devices may be used in lieu of conventional rollers when approved by the Engineer.

The selection of the type of roller to be used on the breakdown rolling may be varied to suit mix characteristics. The final rolling of the top or surface course shall be accomplished with a steel roller unless otherwise designated. When the specified density is not obtained, changes in size and/or number of rollers or compactive device shall be made as corrective measures to satisfy the density requirement.

Rollers or other compactive devices shall be operated by competent and experienced roller men and shall be kept in operation continuously if necessary so that all parts of the pavement will receive substantially equal compaction at the time desired. The Engineer shall order the mixing plant to cease operations at any time proper compacting is not being performed.

#### **Density Requirements**

Any mixture that becomes loose, broken, mixed with foreign material, or which is in any way defective in finish or density, or which does not comply in all other respects with the requirements of the Specifications shall be removed, replaced with suitable material, and finished in accordance with these Specifications.

For specified lift thickness of one and one-half inches (1 1/2") or greater, the bituminous mixture shall be compacted to a Road Density equal to or greater than the percent of the Field Mold Density as set forth below.

**Type Aggregate**

**Required Field**

	<u>Mold Density</u>
Bit. Base Course	95%
Bit. Surface Course	95%
Bit. Shoulders (All Agg. Types)	90%

When the lift thickness as specified is less than one and one-half inches (1 1/2"), the bituminous mixture shall be compacted using a minimum of two (2) approved rollers and in such a manner so as to obtain the best possible consolidation. If available, non-destructive test methods may be used to establish a suitable compactive procedure.

When the area to be compacted is not intended to carry traffic, such as certain types of median areas, compaction shall be achieved by the best suitable equipment, and density requirements may be waived by the Engineer.

### **Contact Surfaces**

Contact surfaces of curbing, gutters, manholes and similar structures shall be painted with a thin uniform coating of emulsified asphalt (CSS-1h) or (SS-1h) material. The bituminous mixture shall be placed uniformly high near the contact surfaces so that after compaction it will be one-fourth inch (1/4") above the edge of such structures.

### **Joints**

Joints between old and new pavements or between successive day's work shall be made so as to insure through and continuous bond between the old and new mixtures. Transverse construction joints in previously laid material may be constructed by cutting the material back for its full depth so as to expose a fresh surface. Where a wooden header is used at a construction joint, the cutting may be omitted provided the joint conforms to the specified thickness and cross-section.

Before placing the fresh mixture against a cut joint or against old pavement, the contact surface shall be sprayed or painted with a thin uniform coat of emulsified asphalt material. Where a finishing machine is used, the longitudinal joint shall be made by overlapping the screed on the previously laid material for a width of at least one inch (1") and depositing a sufficient amount of mixture so that the joint formed will be smooth and tight.

## SECTION 406

### PORTLAND CEMENT CONCRETE PAVEMENT

#### 406.1 DESCRIPTION

This item shall consist of a pavement composed of plain or reinforced jointed Portland cement concrete on a prepared subgrade. The Contractor shall furnish all labor, materials and equipment necessary for the construction of the pavement in accordance with these specifications and in reasonably close conformity to the lines, grades, thicknesses and details indicated by the plans or as established by the Engineer. All tests shall be performed by a laboratory approved by the Engineer.

#### 406.2 MATERIALS

##### Steel Reinforcement

Reinforcing steel for concrete shall be deformed billet-steel bars conforming to the requirements for Grade 40 in the latest revision of Standard Specification for Deformed Billet Steel Bars for Concrete Reinforcement (ASTM A-615). The supplier shall certify in writing that the reinforcing steel meets the required chemical and physical properties. The City reserves the right to sample and test reinforcing bars after arrival at the construction site to verify the supplier's certification. Such test samples shall be duplicate bars not less than 36 inches in length and bars from which such samples are obtained shall be replaced at the Contractor's expense. All reinforcement bars shall be cut and bent in the fabricating shop before shipment to the project, unless otherwise authorized by the Engineer. All reinforcement bars shall be bent cold. All reinforcement bars or steel shall be free from detrimental dirt, scale, grease, oil, fins, tears, excessive rust, or any other foreign substance.

Welded steel wire fabric used as reinforcement for concrete shall conform to the latest revision of ASTM A-185. Gages, spacing and arrangement of wires and dimensions of units in flat sheet form or rolls shall conform to the requirements as specified by the plans or contract. The supplier shall certify in writing that the welded steel wire fabric meets the required chemical and physical properties. The City reserves the right to sample and test welded wire fabric after arrival at the construction site to verify the supplier's certification. All welded steel wire fabric shall be free from detrimental dirt, scale, grease, oil, fins, tears, excessive rust or any other foreign substance.

##### Fiber Reinforcement

###### a) **General**

In lieu of welded wire reinforcement, concrete shall contain polypropylene fibers thoroughly blended into the mixture at the rate recommended by the manufacturer or as specified by the Engineer when special properties are required. The fibers shall be "Fibermesh", "Grace Fibers" or an approved equal. Fiberized concrete shall conform to the fiber manufacturer's specifications. The synthetic fibers shall be manufactured from 100% virgin polypropylene in collated, fibrillated form and shall be alkali resistant, non-absorptive and completely non-corrosive.

###### b) **Specifications**

Fibers shall comply with ASTM C-1116, 4.1.3, Type III for durability and ASTM C-116, Performance Level 1,  $I >^5$  as outlined in Section 21 for toughness. Certification of compliance shall be made available upon request. Standard ACI 302 procedures for placing, finishing, and curing shall be followed.

**c) Mix Requirements**

Fibers may be added to concrete at any point during the batching or mixing process. Fibers may be added to the aggregate during weighing or charging, or to the central mixer or truck before, during, or after charging. The load must be mixed at high speed for five minutes, or 70 revolutions, after the addition of the fibers to insure uniform distribution.

**Cement**

Cement shall meet the requirements of the standard specifications for Portland Cement, ASTM C150, except that the total alkalis (no.  $>_2O+(0.638xK_2O)$ ) shall not exceed 0.60 percent. Type II cement shall have a sum of tricalcium silicate and tricalcium aluminate not exceeding 58.0 percent and the percentage of tricalcium silicate shall not be less than 40 percent in addition to the preceding requirements. Type I cement may be used for all concrete work. Type II cement may be used only when approved by the Engineer. Cement of different types shall not be mixed during storage or used alternately in any one part of a structure. Cement shall be stored in railroad cars or in other suitable moisture-proof storage. Caked or reclaimed cement shall not be used. The cement supplier and the concrete producer shall certify in writing that the cement used conforms to the required chemical and physical properties. The City reserves the right to sample the cement at the concrete production site and to test it to verify the certification.

**Fine Aggregate**

Fine aggregate to be used in concrete shall consist of natural sand resulting from the disintegration of siliceous and/or calcareous rocks and manufactured sand produced by crushing predominantly siliceous materials and shall be uniformly graded from coarse to fine. This type of aggregate shall be free from injurious amounts of organic impurities and from injurious amounts of alkali. Other deleterious substances shall not exceed the following percentages by weight:

Material passing No. 200 sieve	2.0
Shale, lignite, coal, soft or flaky fragments	1.0
Sticks (wet)	0.1
Clay lumps (wet, on No. 4 sieve)	0.25

Fine aggregate shall meet the following gradation requirements when tested as specified by ASTM Method C 136:

Retained on 3/8 inch sieve	0%
Retained on No. 4 sieve	0%-5%
Retained on No. 8 sieve	0%-20%
Retained on No. 16 sieve	15%-50%
Retained on No. 30 sieve	40%-75%
Retained on No. 50 sieve	70%-95%
Retained on No. 100 sieve	90%-100%

The fine aggregate shall also have a fineness modulus of not less than 2.50 or more than 3.40 and the percent retained between any two consecutive sieves shall not be more than twenty-five percent (25%).

Fine aggregates produced or handled by hydraulic methods, and washed aggregates, shall be stockpiled or binned for draining at least 24 hours prior to being used to produce concrete. The City reserves the right to sample fine aggregate at the concrete production site and to conduct tests to verify that the aggregate meets the specified requirements.



**Coarse Aggregate**

Coarse aggregate to be used in concrete shall consist of gravel, crushed gravel, crushed stone or a combination thereof conforming to the requirements prescribed in ASTM C-33, or the latest revisions thereof, except that the percentage of wear shall not exceed forty percent (40%) as tested by the Los Angeles Abrasion Test Method and the loss shall not be more than eighteen percent (18%) as tested for soundness by the Magnesium Sulfate Method. The soundness requirement will be waived if the aggregate meets all the requirements for durability of Class I aggregate as specified in the KDOT Standard Specifications. Coarse aggregates used in concrete mixes shall have a maximum absorption of three and five tenths percent (3.5%).

Grading requirements shall be size No. 67, 3/4" to No. 4	
Retained on 1" mesh sieve	0%
Retained on 3/4" mesh sieve	0%-10%
Retained on 3/8" mesh sieve	45%-80%
Retained on #4 mesh sieve	90%-100%
Retained on #8 mesh sieve	95%-100%

**Various Proportions**

**a) 6.6 Sack City Mix**

Unless noted otherwise, concrete to be used in all construction shall contain 6.6 sacks of cement per cubic yard of concrete minimum; a maximum water content, including surface moisture; but excluding water of absorption of the aggregates of .48 water/cement ratio, maximum. Fine and coarse aggregate shall be combined in such proportions that the limits of the total aggregate retained on the No. 4 mesh sieve will be a minimum of the thirty percent (30%) and a maximum of fifty percent (50%). The maximum permissible slump shall be four inches (4"). Cement and aggregates shall be proportioned at a central mixing plant in which measurement is by weight. Water used in concrete shall be suitable for human consumption. Concrete to be used for all construction shall contain an approved air-entraining admixture in such quantity that the entrapped air will be controlled between four percent (4%) and eight percent (8%). Mixes may also include approved non-chloride accelerators, normal, mid-range and high-range water reducers. When 6.6 sack mix is used, no vehicular traffic shall be allowed on the new concrete for at least seven (7) days or until a flexural strength of 550 psi has been attained.

**b) 8 Sack Sand Mix**

Wheelchair ramps and sidewalks outside of driveway approaches may consist of an approved mixture of sand only with 8 sacks of cement per cubic yard of the concrete. No vehicular traffic shall be allowed on sand mix.

**c) 733 Pound Mix**

When specified for street pavement, curb and gutter, driveways, parking lots, etc., an approved mix with 733 pounds of cement per cubic yard of concrete shall be used.

Street pavement constructed with a 733 pound mix shall be opened to vehicular traffic when flexural strength reaches 550 psi.

Driveway and parking lot pavement constructed with a 733 pound mix shall be opened to vehicular traffic 96 hours after placement without a flexural strength test.

**d) High Early Strength Mixes**

When specified, the Contractor shall provide a high-early (HE) concrete mix to meet the following requirements. All design mixes shall have a minimum 28-day compressive strength of 3500 psi. The use of chloride accelerators will not be permitted.

<u>Designation</u>	<u>Strength (psi)</u>	<u>Time (hrs)</u>
HE-1	3000	6
HE-2	3000	12
HE-3	3000	24
HE-4	3000	36

**Design**

The Contractor shall be responsible for the design and the proper combination of aggregates, cement, and water within the limits of these specifications to produce the best possible mix. The Contractor or concrete producer shall furnish to the Engineer in writing all criteria used in the mix design for each type of concrete including, but not limited to, the saturated and surface dry specific gravity of the individual aggregates, the dry and rodded unit weights of the individual aggregates, the percent by volume of the individual aggregates, the fineness modulus of the individual aggregates, the type of mix, the water content, the design slump, the theoretical weight per cubic foot of the concrete, the gradation of the individual aggregates, the percent by volume of entrapped and/or entrained air, the design moisture condition of the individual aggregates, the quantity of air entraining admixture per cubic yard to produce the design air entraining, the gallons of water to be added per cubic yard of mixed concrete, and the batch weights of aggregate and cement per cubic yard of mixed concrete. The batch weights of the aggregates and the quantity of water in the design mix shall be adjusted to correspond with the moisture condition of the aggregates at the time the concrete is produced. The Engineer shall require the Contractor or concrete producer to re-design any concrete mix when the fineness modulus of the aggregates varies plus or minus 0.20 from the fineness modulus of the aggregates used in the original mix design.

**Mixing**

All proportioning shall be done at a central proportioning plant in which measurement is by weight or approved metering device.

The ingredients of the concrete shall be thoroughly mixed and the consistency of concrete shall be determined by the Standard Method of Slump Test for Consistency of Portland Cement Concrete, ASTM C-143-58. The concrete shall be mixed in quantities required for immediate use. Concrete shall not be used which has developed initial set or is not in place one-half (½) hour after the water has been added. Re-tempering concrete by adding water or by other means will not be permitted. The desired slump shall be three inches (3") to be used in concrete base construction, and the maximum slump permitted shall be four inches (4").

The concrete shall be mixed not less than sixty (60) seconds. When double compartment mixers are used, the minimum mixing time in the first compartment shall be thirty (30) seconds and the total mixing time, including transfer time, shall not be less than sixty-five (65) seconds.

The concrete may be mixed by a paving mixer into which the material, including the water, can be precisely and regularly proportioned, and which will produce a concrete of uniform consistency in color and the materials thoroughly and uniformly mixed.

The paving mixer shall be equipped with a batch meter and automatic locking timing device. The water tank shall be equipped with a scale graduated in gallons and fractions thereof. The water measuring device shall be capable of accurate measurement to within one percent (1%) of the required amount. The paving mixer shall be equipped with a boom and bucket, full power controlled, which shall be so operated

that the batches may be uniformly distributed on the subgrade.

All equipment used to produce, mix and transport concrete shall conform to the applicable sections of the latest edition of the Kansas State Department of Transportation Standard Specifications. Transit mixed concrete may be used for all work in lieu of a paving mixer. Concrete mixed in transit shall conform to the applicable sections of the latest edition of KDOT Standard Specifications.

Concrete used in all construction shall develop a flexural strength of not less than five hundred fifty (550) pounds per square inch in twenty-eight (28) days. Flexural strength shall be determined according to the Standard Method of Test for Flexural Strength of Concrete ASTM C78-57. Conversion factor used in estimating compressive strength based on results of flexural tests shall be determined by the Engineer consistent with materials used.

#### **Curing Compound**

Liquid curing membrane shall conform to the requirements of the KDOT Standard Specifications, latest Edition.

Other curing methods may be used when approved by the Engineer. All curing methods shall be accomplished without additional compensation.

### **406.3 CONSTRUCTION REQUIREMENTS**

#### **Thickness**

The minimum thickness of the concrete pavement shall be as shown by the Plans or as indicated in the Proposal with its upper surface constructed to finished grade without waves or other irregularities in its surface.

#### **Prepared Subgrade**

After the roadbed has been prepared as described in Sections 401-404, it shall be maintained during concrete placement until completely covered. It shall be the Contractor's sole responsibility to maintain the subgrade as prepared and any defects which may develop shall be corrected at his expense. Dry or dusty subgrade shall receive a water spray immediately prior to placing concrete.

#### **Placing Forms and Steel**

Straight forms shall be a metal having adequate thickness to support the equipment and shall be furnished in sections not less than ten feet in length. Forms shall have a depth equal to the prescribed edge thickness of the concrete being placed without any horizontal joints. Forms to be used as track for subgrade planers and finishing machines shall have a base width of at least eight inches wide. Flexible or curved forms of proper radius shall be used for curves of 150 foot radius or less except approved straight forms of five foot length may be used for curves of a radius from 75-to-150 feet. Flexible or curved forms shall be of a design acceptable to the Engineer. The Engineer may approve the use of wood forms in areas requiring hand finishing. The forms shall have provisions for locking the ends of abutting form sections together tightly and for secure setting. The top face of the form shall not vary from a true plane more than one-eighth of an inch in ten feet. Forms shall be staked into place with not less than three pins for each ten foot section and a pin shall be placed at each side of every joint. Form sections shall be tightly locked together at the joints and shall be free from play or movement in any direction. Forms with battered top surfaces, and bent, twisted, or broken forms shall not be used and shall be removed from the project. Repaired forms shall not be used until inspected and approved by the Engineer.

Forms shall be joined securely and set with exactness to the correct grade and alignment and supported firmly during the entire operation of placing and finishing so that they will not deviate more than one-eighth of an inch from a straight edge ten feet in length. A form grading machine shall be used to excavate the subgrade in preparation for setting forms to be used as track for subgrade planers and finishing machines. The foundation under the forms shall be hard and true to grade so that the form,

when set, will be firmly in contact for its entire length and at the specified grade. The building of pedestals of earth to bring the forms to the required grade will not be permitted. The foundation shall be thoroughly tamped, either mechanically or by hand, at both the inside and outside edges of the forms after the forms have been set. No excessive settlement or springing of forms under the finishing machine will be tolerated. When any form has been disturbed or any grade has become unstable, the form shall be reset. The alignment and grade elevations of the forms shall be checked and corrections made by the contractor immediately before placing concrete. Forms shall be cleaned before setting and oiled prior to placing any concrete.

Reinforcing steel bars and fabric shall be set in proper location and position prior to placing concrete, unless otherwise approved by the Engineer. Reinforcement for slabs shall be installed at a location midway between the top and the bottom of the slab, unless noted otherwise on the plans. Bar chairs or other methods approved by the Engineer shall be used to support the reinforcement in the specified position. Bars shall be lapped a minimum of twentyfour inches (24") when it is necessary to splice bars. Fabric shall be lapped such that the lap shall extend beyond the first wire of each sheet and securely wired at intervals not to exceed two feet and six inches (2'6") for the full width of the sheet. Bars shall be securely tied with wire ties at all crossings. Bar Chairs used to support reinforcement shall be fabricated such that they will securely anchor the reinforcement in a lateral and vertical position during the placing of concrete.

#### **Placing and Finishing**

Slip Form Paving machines may be used, provided the machine is electronically controlled and has provisions for accurate conformation to the required grades with the approval of the Engineer.

Concrete shall be placed with a self-propelled finishing machine of suitable design and contour, excepting at intersections and other locations of irregular contour. The finishing machine shall be so operated and manipulated that concrete is uniformly distributed without segregation and, after final passage of the machine, is left uniform in thickness and contour and with the surface free from irregularities. Concrete shall be thoroughly spaded or otherwise manipulated to avoid honeycombing at each edge of the slab or around structures.

Concrete shall be vibrated with a vibrator having a frequency of about 3,000 revolutions per minute, excepting at intersections and other locations in the street which do not have uniform contours. The vibrator shall be the type that will thoroughly and completely agitate concrete from top to bottom for full width of the slab.

Where conditions are such that it is not feasible to use a self-propelled finishing machine and vibrator, a screed with a vibrator attachment may be used in place of the self-propelled finishing machine. Whether the self-propelled finishing machine or screed with vibrator is used will be determined by the Engineer.

The surface of the concrete shall be hand finished to remove any irregularities or corrugations in the surface of the pavement. The finished surface shall be checked with a ten-foot (10') aluminum straight edge just before the initial set of the concrete, and any irregularities more than one-fourth inch (1/4") shall be corrected.

#### **Expansion, Contraction, and Longitudinal Joints**

Expansion joints, unless otherwise approved by the Engineer, shall be constructed using a fibre expansion joint filler meeting the requirements of ASTM D1751.

Non-extruding expansion joints are to be constructed at locations indicated on the plans. Upon approval of the Engineer, expansion joints may be constructed by placing redwood boards meeting the requirements for Type A expansion joint material in the KDOT Standard Specifications.

The expansion joint material shall be placed such that the top of the joint material will be parallel with and 1/2 or 3/4 of an inch (1/2" or 3/4") below the finished surface of the pavement. The joint material must be securely held in place by using metal stakes, metal pins or by other approved methods so that when the pavement is completed the expansion material will be perpendicular to the surface of the pavement. The subgrade shall be trimmed and fine-graded by hand at locations of expansion joints to permit their proper installation when necessary. A 1/2" or 3/4" filler strip having the same width as the expansion material being used shall be fastened to the top of the expansion material in such a way that it can be easily removed upon completion of the edging and finishing of the joint. The filler strip shall not be removed until the concrete has hardened sufficiently to prevent damage to the concrete. The void formed by the removal of the filler strip is to be filled and sealed with the joint sealer specified in this section. No concrete shall extend or run continuously through an expansion joint.

No excavation or trenching will be required or allowed below the top of the completed subgrade as a part of expansion joint construction except where it may be necessary to trim and fine-grade the subgrade slightly to permit proper installation of 3/4" expansion joint material in pavements having widths of 35 feet or less between back of curbs and one inch 1" expansion joint material shall be used in expansion joints in pavements having width of more than 35 feet between back of curbs.

Contraction joints shall be constructed by sawing the pavement with an approved concrete saw at right angles to the curb lines and at intervals or locations as shown by the plans. The saw cut shall be one-fourth of the pavement thickness in depth and a minimum of 3/8" in width. Load transfer bars shall be installed across contraction joints when required by the plans. Load transfer bars shall be installed such that their final position will be parallel with the centerline and surface of the pavement. Pavement reinforcement shall not extend through contraction joints.

The joints shall not be sawed until the concrete has hardened sufficiently to eliminate tearing and raveling. All joints shall be sawed during the initial curing period and before shrinking occurs and uncontrolled cracking takes place. Any procedure which results in premature and uncontrolled cracking shall be revised immediately. All pavement sections with premature and uncontrolled cracking shall be removed and replaced or repaired to the satisfaction of the Engineer.

Longitudinal joints shall be constructed in conformance with the details shown on the typical section for the width of pavement being constructed. When longitudinal joints are constructed at form line joints, an approved keyed joint with tie bars shall be used. When sawed joints are specified or used, the sawing shall conform to the same requirements as specified for contraction joints. Suitable guide lines shall be used when sawing longitudinal joints to cut the joints on the true line as shown on the plans. Joints shall be sawed to a depth equal to one-third (1/3) of the pavement thickness.

Key joints shall be installed in conformance with the typical key joint detail.

#### **Joint Sealing**

All joints shall be sealed with hot-pour type joint sealer meeting the requirements of ASTM 1190.

In contraction and longitudinal joints, heat resistant backer rod shall be installed prior to sealing.

Joints shall be cleaned prior to filling and this cleaning may be accomplished with compressed air jets, air and water under pressure, wire brushed, or in extreme cases the joint shall be re-sawed. The joints shall be filled immediately after cleaning. An approved nozzle designed so that the joint is filled completely from bottom to top shall be used in filing the joints.

#### **Night and Cold Weather Operations**

No concrete shall be mixed, placed, or finished when the natural light is insufficient, unless an adequate and approved artificial lighting system is operated.

Unless authorized in writing by the Engineer, mixing and concreting operations shall be discontinued when a descending air temperature in the shade and away from artificial heat reaches 40°F., and not resumed until an ascending air temperature in the shade and away from artificial heat reaches 35°F.

When concreting is authorized during cold weather, the aggregates may be heated by either steam or dry heat prior to being placed in the mixer. The apparatus used shall heat the mass uniformly and shall be so arranged as to preclude the possible occurrence of overheated areas which might injure the materials. Aggregates shall not be heated directly by gas or oil flame or on sheet metal over fire. When aggregates are heated in bins, steam-coil or water-coil heating, or other methods which will not be detrimental to the aggregates, may be used. The use of live steam on or through binned aggregates will not be permitted. Unless otherwise authorized, the temperature of the mixed concrete shall not be less than 50°F. and no more than 90°F. at the time of placing it in the forms. Under no circumstances shall concreting operations continue when the air temperature is less than 20°F.

If the air temperature is 35°F. or less at the time of placing concrete, the Engineer may require the water and/or the aggregates to be heated to not less than 70°F. and not more than 150°F. No concrete shall be placed on frozen subgrade nor shall frozen aggregates be used in the concrete.

**Time Allowance for Placement**

Maximum time allowed between batching and discharge is as follows:

air temperature < 75° F	1.5 hour
air temperature > 75° F	1.0 hour
concrete temperature > 90° F	45 minutes

**Concrete Curing and Protection**

For concrete curing and protection see Section 408.

## **SECTION 407**

### **CURB, GUTTER, DRIVEWAY APPROACHES, SIDEWALK AND WHEELCHAIR RAMPS**

#### **407.1 DESCRIPTION**

This work shall cover preparation, construction and finishing required to construct curb, gutter, driveway approaches, sidewalk and wheelchair ramps.

#### **407.2 MATERIALS**

Material requirements, proportioning, and mixing of cement, fine aggregate, coarse aggregate, and, reinforcement for curbs, combined curb and gutter, sidewalks and driveways, shall conform to the requirements in Subsection 406.2.

#### **407.3 CONSTRUCTION REQUIREMENTS**

The subgrade for curb, gutter, driveway approaches, sidewalk and wheelchair ramps shall be brought to the proper elevation by excavating or filling as may be necessary to bring the subgrade to the proper distance below the finished grade. The top six inches (6") of subgrade for combined curb and gutter or driveways in cut sections shall have a density equal to or greater than ninety-five percent (95%) of the standard density of the soil involved as determined by the Engineer. The top six inches (6") of subgrade for sidewalk in cut sections shall have a density equal to or greater than ninety percent (90%) of the standard density of the soil involved as determined by the Engineer. Any subgrade for curb, gutter, driveways, and sidewalk that does not meet these density requirements as determined by the Engineer shall be scarified so that the moisture content can be adjusted to a uniform moisture content of not less than five percentage (5%) points below the optimum moisture content of the soil involved as determined by the Engineer and then the subgrade shall be compacted to the required density. No additional payment shall be made for the necessary excavation made below the grade line across the parking as established by the top of the curb and the elevation of the back of the sidewalk. The cost of this excavation shall be included in the unit price bid for the driveways and sidewalk.

When it is necessary to bring the subgrade for curb, gutter, driveway approaches, sidewalk and wheelchair ramps to the proper elevation by filling it shall be accomplished by using suitable excavated material. Fill for combined curb and gutter or driveways shall be constructed to the same requirements as those specified for pavement in Section 401 (Preparation of Subgrade), except the use of a flat steel roller will not be required. Fill for sidewalk shall be constructed to the same requirements as specified for combined curb and gutter or driveways except that the density requirement for the top six-inch (6") layer of the subgrade shall be ninety percent (90%) of the standard density of the soil involved as determined by the Engineer.

All costs for subgrade preparation associated with the construction of driveways shall be included in the unit price bid for Driveway Construction.

All costs for subgrade preparation associated with the construction of curb and gutter, sidewalk, and wheelchair ramps shall be as identified in the contract specifications and in accordance with Section 109.

The Contractor must use accurate gauges, screeds, and finishing machines for grading subgrade and finishing surfaces for the construction of all curb, gutter, driveways, and sidewalks whether constructed in conjunction with pavement or by separate contracts.

A sand cushion may be placed on the foundation prior to construction of curb, gutter, driveway approaches, sidewalks and wheelchair ramps when approved by the Engineer. This sand cushion shall not exceed a thickness of one inch (1"). Forms for curb, gutter, driveways, and sidewalks may be supported by wood stakes to bring the forms to the proper elevation. Undercutting the foundation in excess of one inch (1") below the required grade shall not be permitted and if done the foundation shall be brought to the required elevation with suitable fill material compacted to the specified density by the Contractor without compensation. All form boards used must be full dimensioned for the work to be done and they shall be smooth, straight, and of sufficient strength to resist springing out of shape. Steel forms shall be required unless approved by the Engineer. Forms to be used for construction of combined curb and gutter or integral curb shall meet the same requirements as specified for forms for concrete base course or pavement construction. Curb, gutter, or sidewalk may be constructed by the slip form method, using an approved concrete mix, provided the machine is electronically controlled and has provisions for accurate conformation to the required grades. Forms meeting the specified requirements will be set, and the work finished by hand methods at all discontinuities in the work to insure accurate continuity and uniform appearance of the work. Continued use of slip form type of construction shall depend on the appearance of the work and whether or not the finished work meets the specified requirements. All concrete work must be protected from injury from any source. The surface must be cured with an approved curing compound (see Section 408).

#### **407.4 MIXING AND PLACING CONCRETE**

##### **General**

Concrete shall be placed in accordance with the requirements of Subsection 406.3.

The name of the contractor and the year in which the work was done shall be stamped on both ends of each and every continuous strip of sidewalk, curb or gutter, and driveway. The stamped letters and figures shall be at least one and one-half inches (1 1/2") in height. The stamped letters and figures shall be sharp-faced Gothic with 1 1/2" ( $\pm$  1/8") in height and 3/16" ( $\pm$  1/16") in depth.

All holes left from taking cores by the inspector as authorized by the Engineer to inspect the work must be immediately filled with concrete by the contractor without additional compensation.

Optimum moisture, standard density, field density and/or field moisture content of the various soils shall be determined by the methods as set out in Section 401.

Concrete for wheelchair ramps and sidewalk other than driveway approaches may be 6.6 sack City mix in accordance with Subsection 406.2.

Time allowance for placement of concrete shall be in accordance with Section 406.3

#### **407.5 SIDEWALKS**

All sidewalks shall be a minimum of four inches (4") in thickness with longitudinal joints and transverse contraction joints separating individual sections of walk into squares not to exceed five feet (5'). Longitudinal joints and transverse contraction joints which are cut and tooled shall be formed by inserting a metal template having a minimum thickness of one-eighth inch (1/8") into the concrete to a depth of one-third (1/3) of the thickness of the walk. The edges of all tooled contraction, construction and expansion joints shall be rounded with a one-fourth inch (1/4") radius edging tool.

Sidewalk shall have a minimum cross slope of one-quarter inch (1/4") per foot or a maximum cross slope of one half inch (1/2") per foot unless otherwise directed by the Engineer. Expansion joints one-half inch (1/2") in width shall be constructed in sidewalks on approximately fifty foot (50') intervals along the length of walk constructed. Slip formed sidewalk shall have expansion joints at 120 foot intervals. Expansion



joints shall be made by placing precast fibre expansion joints one-half inch (1/2") thick. Additional expansion joints shall be required where the sidewalk adjoins concrete parking lots, concrete driveways, or where the width of the sidewalk is to be greater than five feet, they shall be placed as directed by the Engineer.

#### **407.6 WHEELCHAIR RAMPS**

Wheelchair ramps shall be constructed in conformance with the typical wheelchair ramp detail. Wheelchair ramps will be paid for as identified in the contract, and shall include the cost of all materials, labor, grooving, painting or coloration necessary to construct ramp. In no case shall wheelchair ramps be steeper than one inch per foot in the direction of pedestrian travel nor more than one-half inch per foot across the direction of pedestrian travel.

#### **407.7 COMBINED CURB AND GUTTER**

The cross section of the combined curb and gutter shall be as shown on the plans.

Contraction joints shall be constructed by sawing the curb and gutter at right angles to the curb line at no more than twelve foot (12') intervals. The saw cuts shall be at least two and one-half inches (2-1/2") in depth and one-fourth inch (1/4") in width. All joints shall be sawed as soon as is practical after the concrete has hardened sufficiently to eliminate tearing and raveling. The maximum allowable time between the placing of the curb and gutter and the sawing of joints shall be twelve (12) hours; however, any procedure which results in premature and uncontrolled crackling shall be revised immediately. The joints shall be filled immediately after sawing with a joint sealer meeting the requirements for sealing concrete pavement joints (Subsection 406.3). A nozzle designed so that the joint is filled completely from top to bottom shall be used in filling the joints.

When combined curb and gutter adjoins concrete base or concrete pavement, it shall be tied to such base or pavement using tie bars. The tie bars shall be two feet (2') long and spaced on two feet six-inch (2'6") centers.

Expansion joints shall be constructed by placing one-inch (1") precast asphalt expansion material at maximum intervals of three hundred feet (300') along the length of the combined curb and gutter, at all radius point locations, and at quarter point locations around cul-de-sacs when the combined curb and gutter construction adjoins full depth asphalt pavement construction. Such expansion joints shall be installed at all radius points and at locations to match expansion joints in the pavement when the combined curb and gutter adjoins concrete pavement construction. Expansion joints shall extend the full depth of the curb and gutter and be trimmed to match the curb profile.

All costs associated with joint construction, keyed joint construction and tie bar installation, including the cost of the steel, shall be incidental to the bid price of the combined curb and gutter.

#### **407.8 MONOLITHIC EDGE CURB**

The item listed as monolithic edge curb shall include the furnishing of all materials and labor necessary to construct a curb monolithic with the concrete pavement and shall be constructed by building pavement one foot wider than the space between the face of the curbs. Curb forms shall be set on each side of the pavement as soon as possible after the last passage of the finishing machine. The curb shall then be constructed on top of the completed pavement using the concrete mix specified for curbs in these specifications. Other methods of curb construction may be used when approved by the Engineer. Dimensions of the monolithic edge curb shall be as indicated by the plans. Monolithic edge curb shall be

cut through the pavement in uniform lengths at approximately ten-foot (10') intervals between expansion joints. Expansion joints shall be constructed in the monolithic edge curb at all locations where there is an expansion joint in the pavement, at all radius points, and at other locations as directed by the Engineer, by placing precast asphalt expansion joints the same thickness as the expansion joint in the pavement. The price bid for monolithic edge curb shall include the cost of placing and furnishing all expansion joints. The price bid for monolithic edge curb shall include only that portion above the pavement.

#### **407.9 DRIVEWAY APPROACHES**

Driveway openings shall be left at such locations as are requested by the property owners. Neither the representatives of the City nor the Contractor shall attempt to make definite location of such driveway openings. Such locations shall be designated only by the interested property owner or his representative. The Contractor will be required to provide a properly executed driveway request form for each driveway constructed with the project, regardless of whether or not such driveways are shown on the plans. All driveways shown on the plans shall be considered as tentative until validated by a properly executed driveway request form. All driveway request forms must be submitted to the Engineer at least ten (10) days prior to the construction of any curb, combined curb and gutter, or driveway approaches on the project. The Contractor shall contact each individual property owner or his representative and have such individual execute a standard driveway request form which shall then be submitted to the Engineer or his authorized representative. Such standard driveway request forms are available at the office of the City Engineer at 455 North Main Street. All driveway construction shall conform to the standard driveway detail sheets which incorporate details adopted by ordinance by the City of Wichita. Such standard driveway detail sheets are available at the office of the City Engineer. No driveway openings shall be constructed without completing the driveway from the street curb line to the property line.

All driveways constructed on public street right-of-way shall be a minimum of six inches (6") in thickness throughout the entire width of the flat slab, including that portion of the sidewalk section within the limits of the drive. Commercial and industrial use drives shall be constructed eight inches (8") in thickness. Commercial and industrial use drives shall be reinforced with 6" x 12", W4-W4 welded wire fabric. Welded wire fabric reinforcement in drives will be paid for at the unit price bid or the unit price set in the proposal per pound as measured on the basis of forty-four hundredths (0.44) pounds per square foot of drive constructed with such reinforcement. The maximum width of any one drive will be thirty feet (30') at the right-of-way line with a maximum opening in the street curb for radius type drives of fifty-two feet (52'). Standard ramp type drives shall be constructed when the distance between the right-of-way line and the back of the street curb is twelve feet (12') or less. Radius type or radius-ramp type drives shall be constructed as determined by the Engineer when the distance between the face of the walk and the back of the street curb is greater than eight feet (8'). The curb radius shall not exceed the distance between the street curb line and the front edge of the sidewalk without special permission from the Engineer.

All driveways constructed adjacent to combined curb and gutter which adjoins full depth asphalt pavement or concrete base pavement construction shall be tied to the combined curb and gutter using No. 4 reinforcing tie bars.

All driveways constructed adjacent to combined curb and gutter which adjoins concrete pavement shall be tied to the concrete roadway at the high edge of the curb and gutter with No. 4 tie bars.

All driveways constructed abutting concrete pavement shall be tied to the pavement one foot back of the curb using No. 4 reinforcing tie bars.

That portion of the driveway between the back of the street curb line and the right-of-way line will be paid for at the unit price bid or set in the proposal per square foot for the thicknesses indicated, which price shall include the cost of all curb along the edges of the driveway, the cost of all necessary excavation and the cost of the subgrade compaction. When combined curb and gutter is constructed, that portion of the gutter and one and one-half inch (1-1/2") curb through the drive opening will be included in the price bid

for combined curb and gutter. When the driveway abuts concrete pavement, the one and one-half inch (1-1/2") curb through the drive opening will be included in the price bid for curb of the same type indicated to be constructed with the pavement. Keyed joints and tie bars installed with keyed joints will not be paid for directly and this cost shall be considered as subsidiary to other work.

This page was left blank for future use.

## **SECTION 408**

### **CONCRETE CURING AND PROTECTION**

#### **408.1 DESCRIPTION**

This work shall cover the curing and protection of concrete pavement, curb and gutter, sidewalk, driveway approaches and slabs.

#### **408.2 CURING CONCRETE PAVEMENT**

Concrete pavement shall be cured by spraying, using approved pressure distributing equipment, with an approved liquid curing membrane while the surface of the concrete is still moist.

Liquid curing membrane shall conform to the requirements of applicable sections of the KDOT Standard Specifications.

Other curing methods may be used when approved by the Engineer.

When liquid curing membrane is applied using approved self-propelled mechanical distributors, the minimum rate of application shall be one gallon per one hundred fifty square feet. When the liquid curing membrane is applied using approved hand sprays, the membrane shall be applied in two applications, the second application applied at right angles to the path of the spray of the first application, and the rate of application shall not be less than one gallon per two hundred square feet for each application. Satisfactory means shall be provided for thoroughly mixing the curing membrane compound before and during use. If from any cause the curing membrane is damaged, such as rainfall soon after its application, the Contractor shall immediately apply another application of curing membrane to the surface of the pavement. All existing expansion, contraction, and longitudinal joints that are to be filled with joint compound shall be protected from the curing membrane by filling with jute rope or by using other acceptable protective material.

#### **408.3 COLD WEATHER PROTECTION**

When concrete is being placed during the time that the air temperature may be expected to drop below 40°F. the Contractor will be required to protect the work by covering it with a suitable moisture barrier such as wet burlap or plastic sheeting and a suitable blanketing material such that will maintain a minimum temperature of 40°F. in the concrete as measured on the surface of the work. This type of curing shall be maintained for a duration of 96 hours after the concrete has been placed as long as the air temperature is expected to go below 40°F. anytime during the 96 hour period.

#### **408.4 PHYSICAL PROTECTION**

The concrete shall be protected from damage due to traffic or pedestrians by use of adequate barricades and signs. If required, the Contractor shall leave personnel to guard the concrete until set up to a point where it cannot be easily damaged. Damaged concrete shall be removed and replaced, at no extra cost, as directed by the Engineer.

this page was left blank for future use.

## SECTION 409

### COLD MILLING PAVEMENT

#### 409.1 DESCRIPTION

This work shall consist of the removal of pavement surfaces in accordance with these specifications. Pavement surface removal area and depth shall be as indicated by the plans and/or Proposals as approved by the Engineer. Where required, milling will also be performed to remove or reduce high spots caused by rutted or channeled roadways, and to remove material to match adjacent street elevations. Cold milling of pavement surfaces will be to required grade lines in areas as established by the Engineer using approved equipment which is automatically controlled, except as otherwise noted, herein, with regard to longitudinal grade and cross slope. Contractor will not be allowed to carry traffic through construction on pavement whose surface has been milled in excess of a 72-hour time limit.

#### 409.2 CONSTRUCTION DETAILS AND REQUIREMENTS

##### **Curb Line Milling**

Curb line milling shall consist of milling to a depth of 1 1/2 inches below the adjacent gutter or curb apron (high edge) if the curb or gutter is on grade, or as otherwise designated by the Engineer. The milling depth shall taper to meet the existing street surface at the width specified by the Engineer. Normally, the milling width will be approximately 6 feet. Milling equipment used for curb line milling shall be capable of milling a straight line parallel with the curb line.

##### **Street Surface Milling**

Street surface milling shall be required to permit construction of the new street surface as identified by the plans and/or Proposals as approved by the Engineer. Where required, milling will also be performed on channeled street surfaces, bumps or high spots and at locations requiring milling to establish differential elevations or smooth transitions from one pavement section to the next.

##### **Loading**

The milled material will be immediately loaded into the contractor's trucks. The loading device shall be capable of removing and loading at least 85 percent of the milled material. The milled material will be removed to a site designated by the Street Maintenance Division and as approved by the Engineer.

##### **Dust Control**

The entire milling and loading operation shall be equipped with an effective dust control system, approved by the Engineer.

##### **Final Cleaning**

The milled area and adjacent areas will be swept or otherwise cleaned to the Engineer's satisfaction. All debris shall be removed and disposed of at a site approved by the Engineer.

This page was left blank for future use.



## SECTION 410

### COLD PLASTIC TRAFFIC MARKING

#### 410.1 DESCRIPTION

This specification is intended to cover white and yellow pre-formed pavement markings for use in marking streets in compliance with the Manual on Uniform Traffic Control Devices (MUTCD). The tape is intended for use in areas subjected to high traffic volumes and severe wearing conditions where there is repeated shear action, stopping, starting, turning, etc.

The tape shall have glass beads for immediate and continuing retro-reflectivity. The tape shall have a pressure sensitive adhesive on it and shall require no paper liner to keep the material from sticking to itself (although paper liners may be required for transverse lines, legends, arrows, etc., for ease of handling). The primary application of the material will be for "inlay" on new hot asphalt surfaces, but it will also be used on existing asphalt and concrete surfaces. Material for long lines shall be furnished in rolls.

#### 410.2 MATERIALS

##### General

The pre-formed markings shall consist of white or yellow films with pigments selected and blended to conform to standard highway colors through the expected life of the film. Glass beads shall be incorporated to provide immediate and continuing retro-reflection.

The size, quality and refractive index of the glass beads shall be such that the performance requirements for the markings shall be met. The bead adhesion shall be such that beads are not easily removed when the material surface is scratched with a thumbnail.

The film shall have glass bead retention qualities such that when a 2" x 6" sample is bent over a 1/2" diameter mandrel, with the 2" dimension perpendicular to the mandrel axis, microscopic examination of the area on the mandrel shall show no more than 10 percent of the beads with entrapment by the binder of less than 40 percent.

The pre-formed words and symbols shall conform to the applicable shapes and sizes as outlined in the MUTCD latest edition.

The pre-formed markings shall be capable of being adhered to asphalt concrete or Portland cement concrete by a pre-coated pressure sensitive adhesive. A primer may be used to precondition the pavement surface. The pre-formed marking film shall mold itself to pavement contours by the action of traffic. The pavement marking films also shall be capable of application to new, dense and open graded asphalt concrete wearing courses during the paving operation in accordance with the manufacturer's instructions. After application, the marking shall be immediately ready for traffic. The manufacturer shall identify proper solvents and/or primers to be applied at the time of application on pavements which have been exposed to traffic, all equipment necessary for proper application, and recommendations for application that will assure an effective performance life. Such materials shall be suitable for use one year after the date of purchase from the manufacturer when properly stored.

##### Composition

The retro-reflective pliant polymer pavement marking film shall consist of a mixture of high quality polymeric materials, pigments, and glass beads distributed throughout its base cross-sectional area, with a retro-reflective layer of beads bonded to the top surface.

**Thickness**

The film without adhesive shall have a minimum thickness of 0.06", unless otherwise specified.

**Patchability**

The pavement marking film shall be capable of use for patching worn areas of the same type film in accordance with manufacturer's instructions.

**Tensile Strength and Elongation**

The film shall have a minimum tensile strength of 40 pounds per square inch of cross-section when tested according to ASTM D 638-76, except that a sample 6" x 1" shall be tested at a temperature between 70°F and 80°F using a jaw speed of 10-to-12 inches per minute. The sample shall have a minimum elongation of 75% at break when tested by this method.

**Acid Resistance**

The beads shall show resistance to etching, hazing or delamination of bead surface after exposure to a one percent solution of sulfuric acid. The test shall be performed as follows:

Soak one gram of beads in 100 cc of one percent H<sup>2</sup>SO<sub>4</sub> solution for 100 hours. Then decant the acid solution and dry the beads at 100°C. Microscopic examination of a sample of the beads shall show no more than five percent of the beads altered by the acid.

**Skid Resistance**

The surface of the retro-reflective pliant polymer film shall provide an initial minimum skid resistance of 45 BPN when tested according to ASTM E 303-74.

**Reflectance**

The white and yellow films shall have the following initial minimum reflectance values at 0.2° observation angles and 86.0° entrance angle as measured in accordance with the testing procedures of Federal Test Method Standard 370. The photometric quantity to be measured shall be specific luminance (SL\*), and shall be expressed as millicandelas per square foot per foot-candle (mcd.ft<sup>-2</sup>.fc<sup>-1</sup>). The metric equivalent shall be expressed as millicandelas per square meter per lux. The test distance shall be 50 feet (15m) and the sample size shall be a 2.0 x 2.5 ft. rectangle (0.61 x 0.76m).

The angular aperture of both the photoreceptor and light projector shall be 6 minutes of arc. The reference center shall be the geometric center of the sample, and the reference axis shall be taken perpendicular to the test sample.

		White		Yellow	
Observation Angle	0.2°	0.5°	0.2°	0.5°	
SL(mcd.ft <sup>-2</sup> .fc <sup>-1</sup> )	550	380	410	250	

**Reflectivity Retention**

To have a good, effective performance life, the glass beads must be strongly ponded and not be easily removed by traffic wear.

**The Taber Abraser Simulation Test** shall be employed to measure reflectivity retention. Using a Taber Abraser with an H-18 wheel and a 125 gram load, the sample shall be inspected at 200 cycles, under a microscope, to observe the extent and type of bead failure. No more than 15 percent of the beads shall be lost due to popout and the performance mode of failure shall be "wear down" of the beads.

### **Effective Performance Life**

The film, when applied according to the recommendations of the manufacturer, shall provide a neat, durable marking that will not flow or distort due to temperature if the pavement surface remains stable. Although reflectivity is reduced by wear, the pliant polymer shall provide a cushioned, resilient substrate that reduces bead crushing and loss. The film shall be weather resistant and, through normal traffic wear, shall show no appreciable fading, lifting or shrinkage throughout the useful life of the marking, and shall show no significant tearing, roll back, or other signs of poor adhesion.

### **Adhesive**

All material for lines, legends, arrows, etc. shall require no paper liner, talc, release paper, etc. to keep the marking tape from sticking to itself in a roll. (Paper liner may be required for transverse lines, legends, arrows, etc. for ease of handling.) Unless otherwise specified, all roll goods shall be burnished without paper liner. Legends and arrows must have the same pressure sensitive adhesive as the roll goods and must have a paper liner for ease of handling. Legends and arrows must conform to the standards of the MUTCD.

For "inlay" application on hot asphalt, the tape shall require no adhesive activator, primers, epoxies, etc. For application on pavement surfaces which have been exposed to traffic, the only requirement shall be for the use of a one part primer to be sprayed on the road surface. Material requiring the mixing of a two-part primer or the application of one part to the adhesive and another part to the pavement will not be permitted. The primer shall be 3M (E-44) or equivalent and shall be for use in a spray applicator available from the manufacturer. The manufacturer shall advise on proper application techniques and required primers for installation on pavement which have been exposed to traffic.

## **410.3 WEATHER LIMITATIONS**

When pavement marking material is applied to Portland cement or cold bituminous surfaces, the pavement temperature shall not be less than 70°F and rising.

## **410.4 CONSTRUCTION REQUIREMENTS**

The pavement to be striped shall be broomed and cleaned prior to application as deemed necessary by the Engineer. The marking shall be supplied complete with a pre-coated, factory applied adhesive, to make possible immediate application to the pavement without the use of heat, solvent or other type adhesive or adhesive operations, unless recommended otherwise by the manufacturer due to climatic or pavement conditions. When the adhesive backing is supplemented by a solvent, or other type of adhesive or adhesive operation, the material used and application shall be in accordance with the manufacturer's recommendation. Application shall be made by placing the marker on the pavement surface, when applied to fresh laid hot mixed asphalt surfacing, with the embedment by roller during the final rolling by the asphalt contractor without twisting, stopping or turning of the roller.

When using cold plastic markings on new Portland cement concrete, sand or shot blast cleaning shall be required to remove curing compounds, laitance, debris and other foreign matter, followed by an air blast. Application of primer and pavement markings shall closely follow the cleaning procedure.

When using durable pavement marking tape, the bituminous surface (over thirty days) to be striped shall be broomed and cleaned prior to application as deemed necessary by the engineer. Application of primer and pavement markings shall closely follow the cleaning procedure.

Except when cold plastic markings are rolled into a hot bituminous surface, a minimum of three (3) passes with a tamping cart and added weights shall weigh a minimum of 250 pounds and have a roller with a deep soft rubber surface. Tamping with the tires of an automobile or truck in lieu of the tamp cart shall not be permitted.

Pavement markings shall extend to the limits of the surfacing project whether specifically detailed or not. New pavement markings shall match to the existing pavement markings.

#### **410.5 WARRANTY**

##### **Material Replacement**

The Contractor shall provide replacement materials and install such replacement materials if the original longitudinal lines, words or symbols are later determined to be inadequate traffic control devices, in less than two years if done on an "inlay" job or one year, if on an existing pavement or new concrete pavement.

#### **410.6 REMOVAL OF EXISTING TRAFFIC MARKINGS REQUIREMENTS**

Pavement markings shall be removed to the fullest extent possible without damage to the pavement surface. Equipment used for the removal of the markings shall be any type that will not appreciably damage the surface or texture of the pavement. All material deposited on the pavement as a result of the removal operation shall be removed as the work progresses.

Any appreciable damage or different appearance from the surrounding surface shall be repaired by the Contractor, at his expense, by methods approved by the Engineer. The Contractor shall treat, at his expense, the affected areas with any permanent or lasting material to blend in and match as well as practical, the appearance of the surrounding area.

Removal of existing traffic markings using methods which require sand blasting, blocking out with asphaltic materials, and other such methods resulting in objectionable staining or marking of the pavement surface will not be permitted. Removal of existing traffic markings will conform to the following methods identified for the various material types using methods and equipment approved by the Engineer which will not result in objectionable staining or marking of the pavement surface.

Painted traffic markings shall be removed by chipping with hand operated or power operated chisels, rotary hammer mills, shot blasting or any other method approved by the Engineer.

Cold plastic traffic markings shall be removed by peeling and scraping using hand operated scrapers.

Thermoplastic traffic markings shall be removed by chipping with hand operated or power operated chisels or manually with the sharp edge of hatchets.

Removal of existing traffic markings will not be measured and will not be paid for directly and the cost of this work will be considered as subsidiary to other pay items of work.