

CITY OF EDMOND
STANDARD SPECIFICATIONS FOR CONSTRUCTION

700.00 MATERIALS

701.00 PORTLAND CEMENT CONCRETE. This Specification covers all materials, classification, mix designs, proportioning and testing of portland cement concrete. All concrete except that used for pre-stressed concrete members shall be air entrained unless otherwise shown on the Plans.

The equipment and tools necessary for the mixing of concrete shall meet the requirements of Subsection 414.03.

701.01 MIX DESIGN AND PROPORTIONING. The materials used shall comply with the requirements of all Subsections of this Specification.

A. Classes of Concrete. The classes of concrete are shown in the following table:

CLASSES OF CONCRETE					
Class of Concrete	Cement lbs. per Cu. Yd. a/	Air Content Percent	Maximum Water-Cement Ratio b/ lb. per lb.	Slump, Inches c/	Minimum Compressive Strength-28 day psi
AA	658	4-6	.49	1-3	3500
A	564	4-6	.53	1-3	3000
B	470	4-6	.58	2-4	2500
C	395	4-6	.62	2-4	2400
P6	611 to 752		.42	1-3	6000
P5	611 to 705		.44	1-4	5000

a/ Fly ash meeting the requirements of Section 702 may be substituted for approximately 15 percent cement in the ratio of 1.35 pounds of fly ash for each 1.0 pounds of cement. This substitution will not be allowed for high early strength concrete or when Type IP cement is used.

b/ The water-cement ratio will be calculated by the following equation:

$$W/C \text{ (Lbs of Water) / (Lbs. of Cement + Lbs. of Fly Ash)}$$

The water actually used is determined by the water measured into the batch plus the free water on wet aggregate minus the water absorbed by dry aggregate and shall not exceed the limit specified.

c/ The slump shall be as shown or as approved by the Engineer, and the consistency required shall be that which will provide satisfactory workability for the type work being done. Slump tests will be made during the progress of the work as a measure of uniformity of the consistency of the concrete.

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When the class of concrete is not expressly indicated on the Plans, the following requirements shall govern:

Class AA – Slabs and girders without wearing surface, concrete piles, handrails and all bridge floors.

Class A – Slabs and girders with wearing surface, pavements, piers, abutments, retaining walls, culverts and all reinforced concrete not requiring Class AA concrete.

Class C – Concrete may be used for soil erosion control structures.

When high early strength concrete is used or specified, it shall meet all other requirements for that class of concrete except that Type III or Type III (AE) cement shall be used. When requested by the Contractor and approved by the Engineer, 25 percent additional Type I cement can be used in lieu of Type III or Type III (AE) cement to achieve high early strength concrete.

B. Proportioning. The mix design shall be based on absolute volume for the class of concrete specified and the consistency suitable for satisfactory placement of the concrete. The Contractor shall submit a mix design for the Engineer's acceptance which shall include all ingredients to be used in the mix. This mix design shall include supporting compressive strength data. The Engineer may require trial batches and require adjustments in the mix as necessary to attain workability and the specified air content when applicable. Adjustments to the mix will be made by the Contractor in a manner to maintain the specified cement factor based on absolute volume. During the progress of the work, no change shall be made in the batch proportions of the ingredients without the approval of the Engineer.

In the event a satisfactory mix with the required workability cannot be produced without exceeding the maximum water specified, the cement content shall be increased so that the maximum water cement ratio will not be exceeded. The Contractor shall not receive additional compensation for the extra cement which may be necessary by reason of such adjustment.

The cement used shall be within 2 percent of the specified amount of cement per cubic yard of concrete. During the progress of the work the Engineer may require the Contractor to verify the yield and require adjustments in the batch proportions as may be necessary to secure the specified cement content within the allowable limits. Any verifications required shall be done at the Contractor's expense.

The batch proportions accepted by the Engineer apply only for materials from the same source and having the same characteristics as the materials used in the mix design. Materials from any other source shall be used only with the approval of the Engineer.

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Should a change in sources of materials be made, a new mix design shall be established by the Contractor before the new material is used. When unsatisfactory results or other conditions make it necessary, the Contractor shall establish a new mix design to get the desired results.

In proportioning the material for batches the least amount of sand and mixing water which will insure concrete of the required workability for the placing conditions involved should be used. Any change in weight of fine aggregate or mixing water made for the purpose of adjusting workability shall be compensated for by proportionate changes in the other mix components in order to maintain the total mix weight and water-cement ratio.

C. Adjustments Due to Temperature. An approved water-reducing, set-retarding chemical admixture shall be added to Class AA concrete when the prevailing ambient temperature is 75° F or above unless otherwise shown on the Plans. The admixture may be used for other types of structural concrete or at lower temperatures if requested by the Contractor and approved by the Engineer.

It is the intent of this Specification that when the admixture is used, it shall be used for a full section, panel or pour.

The admixture shall be used according to the manufacturer's recommendations to reduce the water content and extend the setting time for the specified job conditions.

The Engineer may require trial batches to adjust the amounts of air-entraining agent and amounts of mixing water to produce a concrete of satisfactory consistency and air content.

D. Tests. Slump will be determined using AASHTO T 119, and air content using AASHTO T 121, AASHTO T 152 or AASHTO T 196 as appropriate. Test specimens will be made and cured in accordance with AASHTO T 23 except that after the initial curing, specimens for acceptance testing will be cured in a medium maintained at 40° F to 85° F until they are tested.

Acceptance of test specimens will be tested in accordance with AASHTO T 22 for cylinders.

Unless otherwise provided, the minimum modulus of rupture when test beams are permitted as a criteria for removal of forms, placing a structure in service, etc., shall be 550 pounds per square inch when tested with the third-point method (AASHTO T 97) or 650 pounds per square inch when tested with the midpoint method (AASHTO T 177) or the minimum compressive strength of cylinders shall be 3000 pounds per square inch.

701.02 PORTLAND CEMENT. Portland cement shall conform to the requirements of AASHTO M 85 or AASHTO M 240.

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Type I, Type IA and Type IP shall be used in concrete for general concrete construction. When white portland cement is required, it shall meet the requirements of Type I.

Type II and Type IIA shall be used in concrete exposed to moderate sulphate action or moderate heat of hydration, when specified on the Plans or in the Proposal.

Type III and Type IIIA shall be used when high early strength concrete is required.

Unless otherwise approved by the Engineer, the product of only one mill of any one brand and type of portland cement shall be used on the project, except for reduction of any excessive air entrainment where air entraining cement is used.

The contractor shall provide suitable means of storing and protecting the cement against dampness. Cement which for any reason has become partially set or which contains lumps of caked cement will be rejected. Cement salvaged from discarded or used bags shall not be used.

All methods of sampling and testing shall be in accordance with the requirements of AASHTO M 85 or AASHTO M 240.

701.03 ADMIXTURES (OTHER THAN FLY ASH). Admixtures shall not be used without written permission from the Engineer, except as otherwise provided in these Specifications.

Admixtures shall not be used to replace cement.

Admixtures containing chlorides as C1- in excess of ten thousand ppm shall not be used in pre-stressed or reinforced concrete.

Admixtures shall be measured accurately into each batch by methods approved by the Engineer.

Admixtures shall be dispensed in liquid form. Dispensers for liquid admixtures shall have sufficient capacity to measure at one time the full quantity required for each batch. Unless liquid admixtures are added to pre-measured water for the batch, their discharge into the batch shall be arranged to flow uniformly into the stream of water. The dosage shall not vary more than 5 percent from the dosage established by the Engineer for the mix requirements. Equipment for measurement shall be designed for convenient confirmation of the accuracy of measurement of the admixture dosage.

Admixtures shall be stored in a manner to prevent freezing and shall be agitated to prevent separation or sedimentation of solids. Air agitation shall not be used. If more than one liquid admixture is used, said admixtures shall be compatible and each shall be dispensed by separate equipment, unless otherwise permitted in writing by the Engineer. Any type of admixture shall be uniform in properties

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throughout its use in the work. Should it be found that the admixture as furnished is not uniform in properties, it shall be discontinued.

Only those admixtures shall be used which have been approved by the Engineer. Admixtures may be accepted if the manufacturer presents a Type A certification defined in Subsection 106.12 that the admixture meets all the requirements of AASHTO M 154 or AASHTO M 194 as appropriate.

The Contractor shall furnish the Engineer a Type C certification from the manufacturer with each lot or shipment to the effect that the admixture supplied for use in the work is identical in all essential respects, including concentration, to the admixture tested and approved under these Specifications.

A. *Air Entraining Admixtures.* Air entraining admixtures shall conform to AASHTO M 154.

An exception to the above requirement may be granted in the case of admixtures manufactured by neutralizing vinsol resin with caustic soda provided the manufacturer furnishes certification that the product is neutralized vinsol resin and contains no other additive.

B. *Chemical Admixtures.* Chemical admixtures shall conform to AASHTO M 194 for the particular type specified.

If a high range water reducer is to be used, the mix shall meet the requirements of Subsection 701.01 prior to the addition of the admixture.

After addition of the admixture, the mix shall have a slump of 8 inches or less.

Trial batches shall be required when a high range water reducer is used.

701.04 WATER. All water used in mixing or curing portland cement concrete or cement treated base shall be clean and practically free from oil, salt, acid, alkali, organic matter or other substances injurious to the finished product.

Water from City water supply may be accepted without being tested.

Water from doubtful sources shall not be used until tested and approved. When required by the Engineer, the quality of the mixing water shall be determined in accordance with AASHTO T 26.

When tests are made comparing the water with water of known satisfactory quality, any indication of unsoundness, marked change in time of set, or reduction in mortar strength shall be sufficient cause for rejection of the water under test.

701.05 FINE AGGREGATE.

A. *Materials Covered.* These Specifications cover the quality and size of fine aggregates for portland cement concrete.

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Mortar sand shall meet the requirements of AASHTO M 45.

- B. General Requirements.** Fine aggregate shall consist of natural sand, or subject to approval, combinations of manufactured sand and natural sand, having hard, strong, durable particles and shall conform to these Specifications.

Fine aggregate from different sources of supply shall not be mixed or stored in the same stockpile nor used alternately in the same class of construction or mix, without permission from the Engineer, or as provided herein for manufactured sand.

Fine aggregate shall be stockpiled in accordance with Subsection 106.07.

When manufactured sand is approved for use in combination with natural sand, at least 50 percent of the total fine aggregate by weight shall be natural sand. The two materials shall be stored and batched separately. Each of the materials shall conform to the requirements of these Specifications, except that the mortar strength test shall be made on the blend of materials proposed for use.

- C. Deleterious Substances.** The amount of deleterious substances shall not exceed the following limits:

ITEM	MAXIMUM PERMISSIBLE LIMITS MASS PERCENT
Clay lumps and friable particles	3.0
Coal and Lignite	0.5

- D. Soundness.** When the fine aggregate is subjected to five alternations of the sodium sulfate soundness test, the weighted loss shall not exceed 10 mass percent.

- E. Organic Impurities.** All fine aggregate shall be free from injurious amounts of organic impurities. Aggregates subjected to the calorimetric test for organic impurities and producing a color darker than the standard shall be rejected unless they pass the mortar strength test as specified below. Should the aggregate show a darker color than that of samples originally approved for the work, its use shall be withheld until tests satisfactory to the Engineer have been made to determine whether the increased color is indicative of an injurious amount of deleterious substances.

A fine aggregate failing in the test may be used provided that, when tested for the effect of organic impurities on strength of mortar, the relative strength at 7 and 28 days calculated in accordance with Section 10 of AASHTO T 71 is not less than 95 percent.

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F. Gradation. Fine aggregate shall be well-graded from coarse to fine and when tested by means of laboratory sieves shall conform to the following requirements.

SIEVE	MASS PERCENT PASSING
3/8 inch	100
No. 4	95-100
No. 16	45-85
No. 50	5-30
No. 100	0-10
No. 200	0-3

The gradation requirements given above represent the extreme limits which shall determine suitability for use from all sources of supply. The gradation from any one source shall be reasonably uniform and not subject to the extreme percentages of gradation specified above. For the purpose of determining the degree of uniformity, a fineness modulus (Note) determination shall be made upon representative samples, from such sources as he proposes to use. Fine aggregate from any one source having a variation in fineness modulus greater than 0.20 either way from the fineness modulus of the representative sample may be rejected.

Note: The fineness modulus of an aggregate is determined by adding the percentages by weight retained on the following sieves having square openings, and dividing by 100: 3 in., 1 1/2 in., 3/4 in., 3/8 in., no. 4, no. 8, no. 16, no. 30, no. 50 and no. 100.

G. Methods of Sampling and Testing. Sampling and Testing of fine aggregate shall be in accordance with the following methods of the American Association of State Highway and Transportation Officials:

Sampling	T 2
Friable particles	T 112
Coal and lignite	T 113
Amount of passing a No. 200 sieve	T 11
Organic impurities	T 21
Mortar-making properties	T 71
Sieve analysis	T 27
Soundness (sodium sulfate or magnesium sulfate)	T 104

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701.06 COARSE AGGREGATE.

- A. *Materials Covered.*** These Specifications cover the quality and size of coarse aggregate for use in portland cement concrete.
- B. *General Requirements.*** Coarse aggregate shall be stockpiled in accordance with Subsection 106.07.

Coarse aggregate shall be a gravel or crushed stone which shall conform to the requirements of AASHTO M 80, Class A, except as modified by these Specifications. Coarse aggregate shall produce Class A concrete with a durability factor of 50 or more. The durability factor will be determined after 350 cycles of alternate freezing and thawing in accordance with AASHTO T 161, Procedure A. The Los Angeles Abrasion percent wear shall be limited to a maximum of 40 percent after 500 revolutions, when tested in accordance with AASHTO T 96.

Coarse aggregate shall consist of clean, tough, durable particles, practically free from clay, shale, coatings of any character, disintegrated or soft pieces, conglomerates, mud balls, sticks, salt, alkali, or vegetable matter.

Crushed stone or crushed gravel from different sources may be combined in the mix when batched separately in recommended proportions upon written permission of the Engineer.

At least 70 percent of all aggregate retained on the no. 4 sieve in the combined mix shall be crushed stone or mechanically crushed gravel having two or more fractured faces and shall contain not more than 15 percent of flat and elongated pieces. (A flat and elongated piece is one in which the length is greater than five times the average thickness.)

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- C. Gradation.** The coarse aggregate shall be well-graded within the limits of the following table:

PERCENTAGE BY WEIGHT PASSING LABORATORY SIEVES HAVING SQUARE OPENINGS IN INCHES					
SIEVE SIZE	NO. 3 (2" TO 1")	NO. 357 (2" TO #4)	NO. 57 (1" TO #4)	NO. 67 (<u> </u>" TO #4)	NO. 7 (<u> </u>" TO #4)
2"	100	100			
2"	90-100	95-100			
1"	35-70	100			
1"	0-15	35-70	95-100	100	
3/4"			90-100	100	
1/2"	0-5	10-30	25-60	90-100	
3/8"			20-55	40-70	
No. 4		0-5	0-10	0-10	0-15
No. 8			0-5	0-5	0-5
No. 200	0-1.5	0-1.5	0-1.5	0-1.5	0-1.5

1. Coarse aggregate for Class A and Class AA concrete shall be furnished in the No. 57 size only, except that coarse aggregate for pavements and base courses may be furnished, in the No. 3 and No. 57 sizes, combined. When two separate sizes are used, the batch requirement of each size shall be between 35 and 65 percent of the total quantity of coarse aggregate required for each batch.
2. Coarse aggregate for massive Class A concrete shall be furnished in the No. 357 size. Coarse aggregate for Class C concrete may be either No. 57 or No. 357.
3. Coarse aggregate for thin section concrete shall be furnished in the No. 7 size.
4. Coarse aggregate for Class P5 or P6 concrete shall be furnished in the No. 67 size.

701.07 CURING AGENTS. Concrete curing agents shall consist of burlap, earth, waterproof paper, white or red-pigmented membrane curing compound, polyethylene film, linseed oil emulsion or water for ponding. The curing agents shall be reasonably free from ingredients which may damage or be detrimental to the surface of the concrete.

- A. Burlap.** Burlap cloth shall conform to AASHTO M 182, Class 3 or better.

Burlap shall be new burlap or burlap which has been used for no purpose other than the curing of concrete. New burlap, not previously used for curing concrete, shall be reasonably free from starch, filler, or other substances

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added during the process of manufacturing, or shall be washed by repeated rinsing in clear water until reasonably free from such substances. Worn burlap or burlap with holes will not be permitted. Burlap shall be at least 2 feet longer than the width of the pavement slab.

B. Earth. Earth used in curing concrete pavement shall be reasonably free of roots, sticks, stones, or other ingredients which may be detrimental to the surface of the concrete, and shall be of such nature as to retain moisture.

C. Water for Ponding and Material for Dikes. Water for ponding shall be reasonably free from salt, acid, alkali, oil or any substance that would injure or discolor the surface. Water suitable for use in mixing portland cement concrete will be satisfactory to use for ponding. Material for dikes shall be loam, sand, clay or any combination of the above, free from rocks, sticks or any objects that would prevent formation of a watertight dike.

D. Liquid Membrane Forming Compounds. Liquid membrane forming compounds shall conform to AASHTO M 148 with these exceptions:

The Type 2, white pigmented compound hiding power shall have an apparent daylight reflectance of not less than 65 percent compared to magnesium oxide as determined by ASTM E 97.

The Type 1-D compound shall be colored by a red fugitive dye so that inspection may indicate complete coverage. The color must be maintained at least 4 hours after which it should gradually disappear.

When tested in accordance with OHD L-17, the curing compound shall provide a water retention of at least 90 percent.

E. Sheet Materials. Sheet Materials shall conform to AASHTO M 171. Sheet Material not specifically defined in AASHTO M 171 may be approved providing all other requirements of AASHTO M 171 are met.

The sheeting material shall be fabricated into sheets of such width as to provide a complete cover for the entire concrete surface. All joints in the sheets shall be securely cemented together in such a manner as to provide a waterproof joint.

Sections of membrane which have lost their moisture retaining qualities shall not be used.

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F. *Linseed Oil Emulsion.* Linseed oil emulsion shall comply with the following table of composition:

COMPOSITION	WEIGHT PERCENT
Oil Phase (50% min. by volume)	
Boiled linseed oil	97.0 + 0.1
Saturated Tallow Alcohols	3.0 + 0.1
	100.0
Water Phase (50% Max. by volume)	
Water	99.60 + 0.01
Sodium hydroxide	0.37 + 0.01
Dipicolinic acid	0.03 + 0.001
	100.00

The emulsion shall be stable at the time of application.

Moisture Retention. When tested in accordance with OHD L-17, the curing compound shall provide a water retention of at least 90 percent when applied at the rate of 175 square feet per gallon.

Containers. All linseed oil emulsion furnished under this Specification shall be in plastic containers. Each container shall be marked or labeled with the manufacturer's name, contents Linseed Oil Emulsion, lot number and date of manufacture.

701.08 JOINT FILLERS AND SEALERS. This Subsection establishes the requirements for joint fillers and sealers for portland cement concrete.

A. *Preformed Expansion Joint Filler (Bituminous Type).* This joint filler shall conform to the requirements of AASHTO M 33. This type filler should not be used in joints for which the Plan detail requires a sealer.

B. *Pre-formed Expansion Joint Fillers.* (Non-extruding and Resilient Types).

1. *Non-Bituminous Joint Filler.* The non-bituminous joint filler shall conform to the requirements of AASHTO M 153.

2. *Bituminous Joint Filler.* The bituminous joint filler shall conform to the requirements of AASHTO M 213, except that the maximum permissible load to compress the test specimen to 50 percent of its thickness before testing shall be 1500 pounds per square inch. Compliance with the asphalt content requirement is waived providing the material meets all other physical requirements as specified.

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C. *Pre-formed Elastomeric Compression Joint Sealer.*

1. *Description.* These Specifications cover pre-formed elastomeric compression joint sealers for use in portland cement concrete pavements and concrete bridge floors.

2. *Materials.*

2.1 *Pre-formed Joint Seals.* The joint seals shall be manufactured from an elastomeric material that is resistant to heat, oil, jet fuel and ozone. The material shall be compatible with concrete and shall conform to the physical requirements of AASHTO M 220. All tests will be made on samples taken from the pre-formed joint sealer.

2.2 *Shape and Dimensions.* The molded joint seals shall be of cross-sectional dimensions, lengths and tolerances shown on the Plans. The sealer shall be one piece for the full length of the transverse joint and in the practical lengths for longitudinal joints.

Elongation of the joint material of more than 2 percent during placement will require the pre-formed elastomeric compression joint sealer to be removed and replaced.

2.3 *Inspection.* Representative sections of each lot shall be subject to surface and dimensional inspection by the Engineer to determine visual compliance with applicable requirements of this Specification which do not require physical tests.

2.4 *Lubrication Adhesive.* Any lubricant adhesive used shall be compatible with the sealer and the concrete and relatively unaffected by the normal moisture in the concrete. The lubricant adhesive shall be a compound consisting of the same base polymer as the sealer, blended with a suitable volatile solvent. It shall maintain a suitable consistency at the temperature at which the seal is installed.

2.5 *Certification.* A Type A certification will be required for each lot or shipment of materials.

Any cracking visible after recovery testing is basis for rejection.

D. *Polymer Type, Two Component Cold Applied Machine Extruded and Pourable Joint Sealer.*

1. *Description.* These Specifications cover two component, polymer type, rubberlike, cold applied joint sealing compounds for use in portland cement concrete pavements and bridge floors.

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A primer, when recommended by the manufacturer, shall be used in accordance with the manufacturer's recommendation.

The shape of the joint and joint sealer shall be as shown on the Plans.

2. *Materials.* Materials meeting Federal Specifications SS-S-200 may be used. The bond breaker recommended by the materials manufacturer shall be used as shown on the standard drawings.

- 2.1 *Acceptance.* A Type A certification shall be furnished with each shipment or lot.

- 2.2 *Packaging.* The joint sealer shall be packaged in sealed containers identified by the name of the manufacturer, the manufacturer's lot number, the date of manufacture and shall be bear instructions for mixing and application. Containers including the curing agent shall be marked "A", and the container including the polymer shall be marked "B".

If a primer is required by the manufacturer, it must be so stated on Containers "A" and "B". Proper instructions for use of the primer shall be given on its container.

- 2.3 *Tests.* Tests shall be made in accordance with OHD L-21.

3. *Machine Extruded Joint Sealer.*

- 3.1 *General.* The joint sealer shall be a modified poly sulfide or poly urethane polymer consisting of 2 components to be machine mixed and machine extruded directly into the joints.

The poly sulfide components shall be mixed at a 1:1 ratio by volume and the poly urethane components shall be mixed in accordance with the manufacturer's recommendations.

Upon opening, component B shall not exhibit more than a slight degree of skinning.

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3.2 Properties of Laboratory Mixed Materials.

Penetration at 77° F Penetration at 158° F	50 to 120 1.5 Penetration at 77° F
Cold Flow 3 minutes 40 minutes	inch maximum inch maximum
Resilience at 77° F	70% minimum **60% minimum
Resilience of oven-aged sample at 7 days	70% minimum **60% minimum
Resilience at 158° F	60% minimum **50% minimum
Bond to concrete, 100% extension, dry, at -20° F, a/	No failure
Bond to concrete, 100% extension, dry, at -20° F, a/	No failure
Nonvolatile content	88% minimum

** This requirement applies if penetration at 77° F is 90 to 120.

a/ Cure Sample for 24 hours at 77° F, then oven age for 7 days at 158° F + 2° F.

4. Pourable Joint Sealer.

4.1 General. The joint sealer shall be a polymeric material consisting of two components to be uniformly mixed and poured directly into the joints. The weight of Component A in the mixture shall be not less than 10 percent of the weight used of Component B.

Upon opening, neither component shall exhibit more than a slight degree of skinning.

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4.2 *Properties of Laboratory Mixed Material.*

DETERMINATION	REQUIREMENTS
Viscosity, 5 minutes after mixing	200 to 350 poises
Application time (Pot life or time to reach 2000 poises) at 77° F	1 hour minimum
Penetration at 77° F after 24 hours aging	150 maximum
*Penetration at 77° F	50 to 120
*Penetration at 158° F	1.5 x Pen @ 77° F
*Resilience at 77° F	70% minimum **60% minimum
*Resilience at 158° F	60% minimum **50% minimum
*Resilience of oven-aged sample at 7 days	70% minimum **60% minimum
Bond to concrete, 100% extension, dry, at -20° F a/ 100% extension, wet, at -20° F a/	No failure No failure
Nonvolatile content	88% minimum

- * After 96 hours aging at 77° F.
- ** This requirement applies if penetration at 77° F after 96 hours at 77° F is 90 to 120.
- a/ Cure sample for 24 hours at 77° F, then oven age at 158° F + 2° F for 7 days before testing.

E. Low Modulus Joint Sealant.

1. *Description.* These Specifications cover low modulus silicone joint sealant and expanded polyethylene bond breaker rod for use in sealing portland cement concrete pavement joints. The silicone sealant shall be furnished in a one-part silicone formulation. Acetic acid cure sealants are not acceptable.
2. *Materials.*
 - 2.1 *Silicone Sealant.* The silicone sealant shall meet the current Federal Specification TT-S-001543 for Class A sealants except as modified by the following test requirements:

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TEST	LIMIT	TEST METHOD
Flow	0.3 in. maximum	MIL S 8802
Extrusion Rate	75-250 gms/min.	MIL S 8802
Tack Free Time at 77° F and 45-55% R.H.	20-75 minutes	MIL S 8802
Specific Gravity	1.01 – 1.515	ASTM D 792 Method A*
Durometer, Shore A	10-27 max. @ 0° F	ASTM D 2240*
Tensile Stress at 100% Elong	75 psi maximum	ASTM D 412 Die C*
Elongation, %	500 minimum	ASTM D 412 Die C*

Concrete primer may be used if specified by the sealant manufacturer.
 Note: *Cured 7 days at 77 + 4° F and 50 + 5 percent R. H.

2.1.1. Acceptance. The sealant shall be accepted on the basis of manufacturer's certification and approval by the Engineer in accordance with Subsection 106.12.

A Type A certification shall be furnished for the above listed test requirements.

A Type D certification shall be required for compliance with current Federal Specification TT-S-001543 in accordance with Subsection 2.1 of these Specifications.

2.1.2. Storage and Shelf Life. Storage and use of the joint sealant shall be in accordance with the manufacturer's recommended practices.

2.2. Bond Breaker Rod. The bond breaker rod shall be of the size and dimensions shown on the Plans. The bond breaker rod shall be compatible with the joint sealant and no bond or reaction shall occur between the rod and sealant.

F. Hot Poured Joint Sealer.

1. Description. Joint sealers furnished shall be of the hot poured type which readily bond to concrete surfaces.

2. Materials.

2.1 Sealer. Joint sealers used under these Specifications shall meet the requirements of Federal Specification SS-S-1401. The sealant material shall be heated for application to the temperature within

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the range recommended by the manufacturer unless otherwise established by the Engineer.

2.1.1. *Safe Heating Temperature.* The safe heating temperature shall be set forth by the manufacturer and furnished with samples for approval. The safe heating temperature shall also be shown on all containers and packages in each shipment received at the job site.

2.1.2. *Acceptance.* Hot poured joint sealer furnished under these Specifications will be accepted for use upon receipt of a Type C certification in accordance with Subsection 106.12.

Sealer materials damaged by excessive or prolonged heating will be rejected.

2.2 *Bond Breaker Rod.* When shown on the Plans, the use of a bond breaker rod of the size and dimensions shown shall be required. The bond breaker rod shall be compatible with the joint sealant.

701.09 METAL PARTING STRIPS. These Specifications cover metal parting strips for use in forming longitudinal joints in concrete pavement or concrete base course.

Metal parting strips shall be shaped from metal of the sheet thickness shown on the Plans and shall be free from bends and kinks. It shall conform to the dimensions and be punched for pins and tie bars as shown on the Plans. Punching for pins may not be farther apart than 3 feet center to center. Sections of metal parting strips shall be not less than 10 feet in length and so designed that adjoining sections may be securely fastened together by lapping and pinning, by means of a slip joint, or other approved method.

701.12 PENETRATING WATER REPELLENT FOR TREATMENT OF CONCRETE SURFACES. *Description.* This Subsection covers the material requirements for penetrating water repellents for use on concrete surfaces.

A. General. The penetrating water repellent treatment solution shall consist of an organo silicon compound dissolved in a suitable solvent carrier that, when applied, will produce a hydrophobic surface covalently bonded to the concrete.

The organo silicon compound shall be one of the following:

Alkyl-Alkoxysilane
Oligomeric Alkyl-Alkoxysiloxane

The solvent shall leave less than one percent residue by weight upon evaporation.

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The material shall have met the following performance criteria based on a single application of the solution in accordance with the manufacturer's recommended rate of coverage.

The penetrating water repellent treatment solution shall not stain, discolor or darken the concrete. Application of the solution shall not alter the surface texture or form a coating on concrete surfaces and shall be compatible with the use of special surface finish texture coatings specified in Subsection 509.04 O. Treated concrete shall be surface dry within 30 minutes after application.

B. Test of Treated Concrete Specimens.

1. *Absorption:*

TEST	DURATION	MAX. ABSORPTION	METHOD
Water	48 hours	1% by weight	ASTM C 642
Immersion	50 days	2% by weight	ASTM C 642

2. *Chloride Ion Penetration:*

TEST	DURATION	MAX. ABSORBED CL-	METHOD
Salt Water	90 days	0.75 lb. per cu. yd.	AASHTO T 259
Ponding*		Depth: ½ inch to 1 inch	AASHTO T 260

*Based on non-abraded specimens.

3. *Treatment:*

TEST	MINIMUM DEPTH	METHOD
Penetration	0.15 inch	OHD L 34

4. *Vapor Permeability.* Treated concrete shall retain its moisture vapor permeability as determined by Oklahoma Department of Transportation Laboratory test procedure OHD L-35.

C. Certification. A Type A certification shall be submitted for approval.

A Type C Certification shall be submitted for each lot or shipment of material prior to use.

The manufacturer's recommended rate of coverage for the treatment solution as approved for use under these Specifications shall be included with the Type A and Type C certifications.

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701.13 EPOXY RESIN ADHESIVES FOR GENERAL USE WITH CONCRETE.

Description. This Subsection covers two component, epoxy-resin bonding systems for application to portland cement concrete.

A. General. Epoxy-resin adhesives for general use with concrete shall comply with AASHTO M 235.

If the type, grade and class of epoxy-resin are not specified on the Plans or in the Proposal, the Contractor shall furnish an epoxy-resin system that is appropriate for its intended use in accordance with AASHTO M 235.

Epoxy-resin adhesives for bonding pavement markers to pavement surfaces shall meet the requirements of Subsection 736.04 of these Specifications.

B. Acceptance. The Contractor shall furnish a Type A certification for each batch or lot of each component.

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702.00 FLY ASH

702.01 DESCRIPTION. This Section covers fly ash to be used as an admixture for concrete and to modify or stabilize soils. Fly ash shall meet the requirements of ASTM C 618, Class C or Class F.

The product of only one plant shall be used on the project, unless otherwise approved by the Engineer. The Contractor shall provide suitable means of storing and protecting the fly ash against contamination and dampness. Fly ash which has become partially set, contains lumps of caked fly ash or has been contaminated will be rejected.

All methods of sampling and testing shall be in accordance with the requirements of ASTM C 311.

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703.00 MINERAL AGGREGATE, MISCELLANEOUS USES

Description. This Specification covers the requirements of mineral aggregate intended for various uses not specifically covered in other sections of these Specifications.

703.01 AGGREGATE FOR AGGREGATE BASE.

A. *Materials Covered.* These Specifications cover the aggregate for use in the construction of aggregate base courses Section 303.

B. *General Requirements.* The aggregate base course material shall consist of an intimate mixture of graded aggregate, coarse and fine, and shall be practically free from vegetable or other deleterious substances. Coarse aggregate (material retained on a No. 10 sieve) shall consist of sound, tough, durable particles or fragments of gravel, stone, mine chats, disintegrated granite, crushed concrete, or other inert finely divided mineral matter.

At least 40 percent of that portion of the completed mixture retained on the No. 4 sieve shall be composed of uniformly graded crushed particles (pieces of aggregate with one or more fractured faces resulting from the artificial crushing).

C. *Physical Properties.* The coarse aggregate retained on the 3/8 inch sieve of the finished mixture shall have a percent of wear, Los Angeles Abrasion Test, of not more than 50. No source of material used in the blend shall have a percent of wear of more than 50.

D. *Gradation.* The graded aggregate when uniformly blended and sampled from trucks or windrows shall conform to the following requirements depending on the type being used. Materials for base courses which contain oversize particles of rock, gravel, lumps of clay or conglomerated material shall not be loaded into vehicles for delivery to the road. Such oversize particles of aggregate must be screened, crushed or otherwise processed to meet the Specifications before delivery to the road. The samples taken from trucks or windrows after the graded aggregate has been uniformly blended, shall conform to the gradation limits for the type being constructed, as follows:

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SIEVE SIZE	PERCENT PASSING	
SQUARE	TYPE A	TYPE B
3 in.		100
1½ in.	100	40-100
¾ in.	40-100	30-75
3/8 in.	30-75	25-60
No. 4	25-60	20-50
No. 10	20-43	15-35
No. 40	8-26	7-22
No. 200 a/	4-12	3-10

a/ Note: The material passing the No. 200 sieve shall not be greater than 2/3 of the amount of material passing the No. 40 sieve.

E. Characteristics of material passing the No. 40 sieve.

For all types, the material passing the No. 40 sieve shall conform to the following:

The plasticity index shall not exceed 6

The liquid limit shall not exceed 25

The blending of separate aggregates will be permitted to produce an aggregate mixture meeting the above requirements providing no individual aggregate has a plasticity index in excess of 8.

F. Sampling and Testing. Tests shall be conducted in accordance with the latest revision of the following AASHTO Methods except as noted:

Los Angeles Abrasion	T 96
Sieve Analysis	T 27
Sampling	T 2
Determining Plastic Limit & Plasticity Index	T 90
Fractured Faces	OHD L-18
Method of Preparation of Samples	T 87
Determining Liquid Limit	T 89
Standard Density	Method D

703.02 COVER AGGREGATES FOR BITUMINOUS SURFACE TREATMENTS.

A. Material Covered. This section establishes the requirements for aggregate to be used in construction of various items throughout these specifications.

B. General Requirements. The aggregate shall consist of clean, sound and durable particles of mine chats, crushed gravel, or crushed stone. The

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material shall be of uniform quality throughout with not more than 5 percent of slate, shale or soft stone particles and shall be substantially free from organic matter, clay, loam, or objectionable coating. A minimum of 75 percent of the aggregate retained on the No. 4 sieve shall have 2 or more mechanically fractured faces.

The aggregate shall be reasonably dry when placed.

After the work starts, the same kind of material shall be used throughout the project unless otherwise permitted in writing by the Engineer.

C. Physical Properties. The aggregate shall conform to the following requirements:

Los Angeles Abrasion, % wear	40 max.
Durability, Dc Factor	40 min.
Flat or elongated pieces, % (length is greater Than 5 times the average thickness)	15 max.

D. Gradation. The gradation requirements for aggregates shall be as follows:

PERCENT PASSING			
Sieve Size	No. 1 Aggregates	No. 2 Aggregates	No. 3 Aggregates
¾ in.	100		
5/8 in.			100
½ in.	25-60	100	90-100
3/8 in.	0-15	90-100	40-75
No. 4	0-5	0-25	0-15
No. 8		0-5	0-5
No. 200	0-2	0-2	0-2
*Dust Coating	0-1	0-1	0-1

*Dust Coating on aggregates retained on No. 8 sieve shall be determined by wash loss (AASHTO T 11) after dry sieving.

The specific gradation of gradations shall be used throughout the project unless otherwise permitted in writing by the Engineer.

E. Pre-coated Cover Aggregates. When pre-coated material is specified, cover aggregate meeting the above Specification requirements shall be treated with bituminous material meeting the requirements of Subsection 708.03. The application of bituminous material is to be within the range of 0.30 to 1.75 percent by weight of the untreated aggregate, depending on the type and grade of bituminous material applied. The quantity applied shall be sufficient to satisfy the particular needs of surface absorption, dust dissipation and film coating of the aggregate to be treated. The coating shall be durable and free

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of scales and blisters. When applied to the road, it shall be free of excess binder or moisture which might hinder the handling, spreading or rolling operations. The producer shall obtain the approval of the Materials Engineer pertaining to the type, grade, and amount of asphalt treatment prior to starting production.

The producer shall consistently ascertain that the aggregate is free of surface or absorbed moisture which will interfere with binder absorption and adhesion, or cause blisters or subsequent scaling of the treatment. However, when it is advisable or necessary to facilitate uniform coating of the aggregate with the bituminous material, water may be added at the pugmill in an amount not to exceed 2 percent by weight of the aggregate. When heating is required, or elected by producer, he shall maintain the bituminous materials at temperatures below the flash points or damaging temperatures. The temperatures of asphalt materials shall be within the mixing range for the particular type and grade as shown in Subsection 708.03 C. during application of the asphalt material to the aggregate.

Flow quantities of the treated aggregate shall be such that it may be satisfactorily spread by approved mechanical spreading devices.

The required percent of asphalt for pre-coating the aggregate shall be determined by inspection of the type and grade of bituminous material and aggregate used.

F. *Sampling and Testing.* Sampling and testing shall be conducted in accordance with the following AASHTO methods except as noted:

Sampling	T 2
Sieve Analysis	T 27
Los Angeles Abrasion	T 96
Dust Coating (Plus No. 8 material after dry sieving)	T 11
Durability, Dc Factor	T 210
Soft Particles	OHD L-38
Fractured Faces	OHD L-18

703.03 AGGREGATES FOR TRAFFIC BOUND SURFACE COURSE.

A. *Materials Covered.* This Subsection covers the requirements and test methods for aggregates to be used in the construction of traffic bound surface course in Section 403.

B. *General Requirements.* Traffic bound surface course material shall consist of an intimate mixture of graded aggregate, coarse and fine, and shall be practically free from vegetation or other deleterious substances. Coarse aggregate, material retained on a No. 10 sieve, shall consist of sound, tough, durable particles or fragments of gravel, stone, mine chats, disintegrated

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granite, or combination thereof, crushed to size if necessary. Fine aggregate shall consist of sand, stone dust, or other inert finely divided mineral matter.

C. Physical Properties. The coarse aggregate retained on the 3/8 inch sieve of the finished mixture shall not have a percent wear of more than 40 when tested in accordance with the Los Angeles Abrasion Test.

D. Gradation. This Specification permits the selection and use of one of 5 gradations or types of surface course. The type required on the project may be specified in the bid item of the Proposal. When the type is not so specified, the Contractor may select the gradation or type in advance of construction. The material produced or processed shall conform in gradation for the type specified or selected. After work starts the same type of material as specified or selected shall be used throughout the project unless otherwise permitted in writing by the Engineer.

If the Contractor elects to deliver oversized particles of rock, gravel, lumps of clay or conglomerate materials to the road, all oversize material shall be crushed to meet the Specification sizes and shall then be incorporated in the surfacing material.

PERCENT PASSING					
SIEVE SIZE	TYPE A a/	TYPE B b/	TYPE C c/	TYPE D d/	TYPE E e/
1 1/2 in.				100	
1 in.	100	100	100	90-100	
3/4 in.	95-100	95-100			
1/2 in.				25-60	
No. 4	5-75	0-85	40-75	0-5	
No. 20	0-30				
No. 40			20-40		
No. 200	0-10	0-20	8-25		
Plasticity Index			8-18		
Liquid Limit			Not more than 35		

- a/ Type A material shall consist of hard durable particles of sand, gravel, mine chats, crushed rock or a combination of these materials.
- b/ Type B material shall consist of hard, durable particles of disintegrated granite with natural binder.
- c/ Type C material shall produce a bonded traffic bound surface course and shall consist of an intimate mixture of graded aggregate, coarse and fine. Coarse aggregate (material retained on a No. 10) sieve shall consist of sound, tough, durable particles or fragments of gravel, stone, disintegrated granite or combination thereof, crushed to size if necessary.

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Fine aggregate shall consist of sand, stone dust, or other inert finely divided mineral matter.

- d/ Type D material shall consist of hard durable particles of gravel or crushed stone.
- e/ Type E material shall meet the requirements for Aggregate Base, Type A in Subsection 703.01.

E. *Sampling and Testing.* Applicable methods of Subsection 703.01 F. shall apply.

703.04 COVER MATERIAL FOR PIPE UNDERDRAINS.

A. *Coarse Cover Aggregate.* Coarse cover material shall be gravel or crushed stone with a minimum durability, Dc factor, of 40, a maximum abrasion loss of 50 and shall conform to the following gradation requirements:

Passing 1/2 inch sieve	100%
Passing 3/8 inch sieve	90-100%
Passing No. 4 sieve	20-55%
Passing No. 16 sieve	5-30%
Passing No. 50 sieve	0-10%
Passing No. 100 sieve	0-5%

B. *Filter Sand.* Filter sand shall be well-graded sand and conforming to the following requirements:

Passing 3/8 inch sieve	100%
Passing No. 4 sieve	95-100%
Passing No. 8 sieve	45-85%
Passing No. 16 sieve	5-30%
Passing No. 50 sieve	0-10%

C. *Sampling and Testing.* Sampling and testing shall be in accordance with the following AASHTO methods:

Sampling	T 2
Sieve Analysis	T 27
Durability, Dc Factor	T 210
Los Angeles Abrasion, % loss	T 96

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704.00 SOIL AGGREGATES

704.01 SOIL AGGREGATES FOR SUB-BASES. *Description.* These Specifications cover the material for use in the construction of a sub-base foundation course in Section 306.

A. *Materials.* Sub-base material shall conform to the requirements listed herein for the type material designated on the Plans or in the Proposal. Unless otherwise shown on the Plans, the Contractor shall furnish soil aggregate for sub-bases. The Contractor shall make such preliminary investigations as may be necessary to locate the proposed source of acceptable material. Information obtained by the Department in its preliminary investigations will be available to prospective bidders at the Materials Laboratory. Sub-base materials shall meet the specified requirements before incorporation in the work. No material shall be delivered to the roadbed when the plasticity index exceeds the specified requirements by more than 2 points.

Type I. Sub-base material to be used in this work shall pass a 2 inch sieve. Any material hauled on the project which does not reduce to 2 inches or less shall be removed from the right-of-way limits.

The material passing the 2 inch sieve and retained on the No. 10 sieve shall be composed of sound and durable particles. Lumps or clods will be broken down for testing.

The fraction passing the No. 10 sieve shall conform to the following gradation:

Passing the No. 200 sieve, 5 percent – 45 percent

The soil constants determined for the fraction passing the No. 40 sieve shall be as follows:

Liquid Limit not more than	30
Plasticity Index not more than	10

Type II. Sub-base material to be used in this work shall be produced from approved sandstone deposits including pack sand and non-solidified sand in the same deposit. Unsuitable overburden shall be stripped as directed by the Engineer and production shall exclude clay pockets and deleterious shale beds.

The sandstone material shall have a Jar Slake test value of 4, 5, or 6.

The sandstone material shall be crushed sufficiently to produce 100 percent passing the 3-inch sieve and to secure the specified density and finish requirements. If the Contractor so elects, the material may be crushed on the roadbed.

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Samples shall be prepared for test by crushing or pulverizing in the laboratory. The fraction passing the No. 10 sieve shall conform to the following gradation:

Passing the No. 200 sieve, 5 percent to 45 percent

The soil constants, determined for the fraction passing the No. 40 sieve shall be as follows:

Liquid Limit no more than	30
Plasticity Index not more than	10

Type III. Sub-base material to be used in this work shall be a soil aggregate obtained from an approved source. Material retained on the No. 10 sieve shall be composed of sound and durable particles or fragments of sand, gravel, crushed stone, crushed concrete, mine chat, disintegrated granite, stone screening or a blend of these materials. The gradation and soil constants shall conform to the requirements of the table for grading A, B, and C. The grading for Type III Sub-base shall be as specified on the Plans or in the Proposal.

Processing, including blending may be necessary to comply with the grading or soil constants requirements for the grading specified.

TABLE REQUIREMENTS FOR GRADING AND SOIL CONSTANTS			
SIEVE SIZE SQUARE	PERCENTAGE BY WEIGHT PASSING		
	GRADING A	GRADING B	GRADING C
2 ½ in.	100		
2 in.	90-100	100	100
1 ½ in.	60-100	95-100	95-100
3/8 in.	30-75		
No. 4		45-100	
No. 10	15-50	25-100	55-100
No. 40	8-35	10-50	30-70
No. 200	3-20	3-20	8-25
Liquid Limit	-35	-35	-30
Plasticity Index	-15	-12	-10

The fraction passing the No. 200 sieve shall not be greater than 2/3 of the fraction passing the No. 40 sieve.

Type IV. Sub-base material to be used in this work shall meet the requirements for Type III, Grading B, with the additional requirements that the soil constants as determined for the fraction passing the No. 40 sieve shall be:

Liquid Limit not more than	25
Plasticity Index not more than	6

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B. *Sampling and Testing.* Sampling and testing shall be done in accordance with the following AASHTO methods:

Sampling	T 2
Sieve Analysis	T 88
	(omitting Hydrometer Test)
Preparing Samples	T 87
Liquid Limit	T 89
Plastic Limit and Plasticity Index	T 90
Jar Slake Test	OHD L-37
Standard Density	T 99

704.02 SOIL AGGREGATE FOR SAND CUSHION. *Description.* These Specifications cover the material for use as sand cushion for concrete in Section 308.

A. *Materials.* Sand cushion shall all pass a one-inch sieve and shall contain 5 to 35 percent of material passing the No. 200 sieve. The final material shall have a liquid limit not exceeding 35 and a plasticity index not to exceed 8.

The material shall consist of natural sand, or subject to approval, combinations of manufactured and natural sand, having hard, strong, durable particles and shall conform to these Specifications.

When manufactured sand is approved for use in combination with natural sand, at least 50 percent of the total material shall be natural sand.

B. *Sampling and Testing.* Sampling and testing shall be in accordance with AASHTO methods except where otherwise specified.

Sampling	T 2
Sieve Analysis	T 27
Liquid Limit	T 89
Plastic Limit & Plasticity Index	T 90
Standard Density	T 99

704.04 SOIL AGGREGATE FOR CEMENT TREATED BASE. *Description.* This Subsection covers the requirements and test methods for soil aggregate for cement treated base in Section 312.

A. *Source of Materials.* Suitable soils meeting these requirements shall be obtained from sources furnished by the Contractor and approved by the Engineer. The Contractor will be responsible for testing both the suitability and adequacy of the source proposed for use.

The Contractor shall make such preliminary investigations as may be necessary to locate the proposed source of suitable material.

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The Contractor shall open the proposed source of suitable soil for the Engineer to inspect. Such explorations as are necessary shall be made by the Contractor to obtain sufficient samples to be fully representative of the deposit. Each sample shall be representative of the full depth proposed for use. Tests of these samples will be made to determine if the material is suitable, the extent of the suitable material, and the proportioning of portland cement required. Sampling and testing of the proposed source in advance of construction operations is required.

Tests to determine the cement requirements will be made only from samples obtained.

Excavation and production of the suitable material shall be done in a manner to deliver to the mixer a homogenous mixture represented by the samples which were used to determine the cement requirement.

- B. Soil.** The soil aggregate to be used in the soil-cement base shall be sand, sand-gravel, silty sand, sand-clay, silt clay soil, limestone screenings, sandstone, or jig sand obtained from approved sources and shall be free of roots, sticks and sod tufts and reasonably free of deleterious concentrations of other organic matters, acids and minerals. It shall meet the following requirements prior to addition of cement:

Passing the 2 inch sieve	100%
Passing the 1 inch sieve	95-100%
Passing the No. 4 sieve	Not less than 55%
The silt and clay fraction (smaller than 0.05 mm)	Not more than 50%
The clay and colloid fraction (smaller than 0.005 mm)	Not more than 20%
The liquid limit	Not more than 35
The plasticity index	Not more than 9

- C. Mixtures.** The proportions of soil-cement and water for each soil shall be determined by laboratory tests.

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D. *Sampling and Testing.* Sampling and testing shall be done in accordance with the following AASHTO methods:

Sampling	T 2
Water	T 26
Preparation of Samples	T 87
Mechanical Analysis	T 88
Liquid Limit	T 89
Plastic Limit and Plasticity Index	T 90
Target Density	T 134

The target density shall be determined in the field by moisture density tests on representative samples of cement treated mixture obtained from the roadway. The test method for the target density is AASHTO T 134 modified to provide one compacted specimen of the soil-cement mixture as obtained from the roadway, and separate portions of the sample used for additional specimens with the moisture reduced or increased. The soil-cement mixture shall be mixed and compacted within + 2 percentage points of optimum moisture content specified by the Engineer before there is any appreciable moisture loss.

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705.00 SELECT BORROW

Description. This Subsection covers the requirements and test methods for select borrow in Subsection 202.02 F.

705.01 MATERIALS.

A. General Requirements. Select borrow for use under these Specifications shall be a material meeting the following group classifications and group index values as defined in AASHTO M-145.

GROUP CLASSIFICATION	GROUP INDEX (MAXIMUM VALUE)
A-1	(0)
A-2-4	(0)
A-3	(0)

This soil group shall be limited to a maximum of 40 percent passing the No. 200 sieve.

When a lens, layer or stratum of material is found in a borrow pit or roadway cut and is intended for use by the Contractor which does not comply with the specified requirements, it may be included in the mixture if a uniform blend of acceptable material will result from the blending and mixing accomplished in the production, loading, handling and placement operations, in the normal course of construction. Any additional testing shall be done by the Contractor at his expense if unsuitable material is used.

The material shall be uniform in gradation and plastic properties throughout the entire plan depth.

Unless otherwise provided, the Contractor shall furnish all materials for select borrow. The Contractor shall make such preliminary investigations as may be necessary to locate and verify the proposed source of acceptable material.

B. Sandstone. If select borrow is specified to be from a sandstone or sand rock formation, the material shall be produced from approved sandstone deposits including pack sand and non-solidified sand in the same deposit. Unsuitable overburden shall be stripped as directed by the Engineer and production shall exclude clay pockets and deleterious shale beds.

The sandstone material shall have a Jar Slake test value of 4, 5 or 6.

The sandstone material shall be crushed sufficiently to produce 100 percent passing the 3-inch sieve and to secure the specified density and finish requirements. If the Contractor so elects, the material may be crushed on the roadbed.

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Samples shall be prepared for test by crushing or pulverizing in the laboratory. The fraction passing the No. 10 sieve shall conform to the following gradation:

Passing the No. 200 sieve	5-45%
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The soil constants, determined for the fraction passing the No. 40 sieve shall be as follows:

Liquid Limit not more than	30
Plasticity Index not more than	10

C. Testing. Testing shall be in accordance with the following AASHTO Methods except as noted:

Sieve Analysis	T 88
	(Omitting Hydrometer Test)
Preparing Samples	T 87
Liquid Limit	T 89
Plastic Limit & Plasticity Index	T 90
Jar Slake Test	

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706.00 LIME

Description. These Specifications cover lime requirements for lime treatment of soils in Section 307.

706.01 HYDRATED LIME.

A. Definition. Hydrated lime for stabilization shall consist essentially of a calcium hydroxide with a lesser amount of calcium oxide, magnesium oxide and magnesium hydroxide made from a dry powder obtained by treating quick-lime with enough water to satisfy its chemical affinity for water under the conditions of its hydration.

B. Chemical Composition. When tested under the appropriate sections of ASTM C 25, the lime shall conform to the following requirements:

Available calcium hydroxide.
Available lime index (as is basis) expressed as Ca(OH)₂ – Not less than 90 percent.

C. Fineness. When tested under the appropriate sections of ASTM C 110, the lime shall conform to the following requirements:

Percent passing No. 20 sieve	99 or more
Percent passing the No. 200 sieve	80 or more

706.02 QUICK LIME.

A. Definition. Quick lime for stabilization purposes shall consist of a calcined material, the major part of which is calcium oxide or calcium oxide in natural association with a lesser amount of magnesium oxide capable of slaking with water.

B. Chemical Composition. When tested under the appropriate sections of ASTM C 25, the lime shall conform to the following requirements:

Available calcium hydroxide expressed as calcium oxide.
Available lime index (as is basis) expressed as CaO – not less than 90 percent.

C. Fineness. When tested under the appropriate sections of ASTM C 110, the lime shall conform to the following requirements:

Percent passing the no. 200 sieve	90 or more
Slaking Temperature Rise	40° C or more
Total active Slaking Time	20 minutes or less

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When tested in accordance with method OHD L-28 the lime shall conform to the following requirements:

Percent passing 5/8 in. sieve	95 or more
Percent passing the no. 200 sieve	15 or less

706.03 BY-PRODUCT LIME. By-product lime will be tested under the appropriate sections of ASTM C 25 to determine the available lime index (by rapid sugar method) expressed as available calcium hydroxide Ca(OH).

Calculations will be based on the dry weight of the material. Sufficient tonnage of the by-product lime shall be required to provide an equivalent amount of available lime based on 90 percent availability per ton (dry weight) of hydrated lime.

706.04 AGRICULTURAL LIMESTONE. Agricultural limestone shall be a high calcic or dolomitic limestone having a neutralization value of at least 80 percent of calcium carbonate. It shall be of such fineness that 100 percent passes the No. 4 sieve, at least 90 percent passes the No. 8 sieve, and at least 30 percent passes the No. 60 sieve. The neutralization value and sieve analysis shall be in accordance with ASTM C 602. The material shall be free from harmful quantities of toxic salts and other objectionable matter.

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708.00 PLANT MIX BITUMINOUS BASES AND SURFACES

Description. This Section covers the materials requirements, mix designs, proportioning, mix tolerances, and sampling and testing methods for plant mixed bituminous bases and surfaces.

708.01 APPROVAL OF MATERIALS. Prior to use, aggregate sources and percentage of blends must be approved by the Engineer.

The aggregate shall be stockpiled in accordance with Subsection 106.07 and may be accepted in stockpile at the plant site. The plant mixed materials may be accepted after blending and mixing at the plant. Asphalt must be obtained from an approved source and may be conditionally accepted in accordance with Subsection 708.06 B.

708.02 MINERAL AGGREGATE. The mineral aggregate shall be composed of coarse aggregate, fine aggregate and mineral filler as required to meet these Specifications. If natural gravel is to be crushed for use in any of the mixes, a washing operation may be required to provide complete separation of all fines which may be stuck to the gravel. In no case will the blending of different material in the same storage or feeder be permitted.

The aggregates shall meet the requirements set forth in Table 1.

The use of a crusher run or similarly graded aggregate shall not be the sole source of crushed coarse aggregate in asphalt concrete, Types A, B and C.

A. Coarse Aggregate. The coarse aggregate shall be that part of the aggregate retained on the No. 10 sieve and shall consist of clean, tough, durable particles. It shall be practically free from soft and disintegrated pieces, shale, clay, organic or other injurious matter occurring either free or as a coating on the aggregate.

Natural gravel shall not be used a source of insoluble material unless it has been crushed so that at least 75 percent of the material retained on the No. 4 sieve has two or more mechanically fractured faces. The natural gravel used as a source of insoluble materials shall have not more than 30 percent passing the No. 4 sieve after crushing except when used in asphalt concrete, Type D.

B. Fine Aggregate. Fine aggregate shall be that part of the aggregate passing the No. 10 sieve and shall consist of hard, durable grains of natural sand, crushed stone, stone dust, crushed gravel, mine chat or jig-sand or any combination of these materials. Crushed materials shall be produced from material conforming to the requirements of coarse aggregate.

When used in the wearing course, the material in the natural sand passing the no. 200 sieve shall be less than 50 percent of that contained in the combined aggregate including mineral filler.

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- C. Mineral Filler.** Mineral filler, when required in addition to that naturally contained in the aggregate, shall conform to AASHTO M 17.

TABLE 1		
PHYSICAL PROPERTIES OF AGGREGATES		
Aggregates to be used in:		
TEST	ASPHALT CONCRETE	HOT MIX COLD
L. A. Abrasion (max. % wear) a/ Sand Equivalent (min.) b/ Wearing Course Base or Binder	40 45 40	40 45 40
Mechanically fractured Faces (min. %) b/ c/	75 w/2	75 w/2
Durability Dc factor (min.) a/	40	40
Insoluble residue (min. %) d/ e/	30	NA
Flat or elongated pieces (max. %) b/ c/ f/	15	15
Clay balls and Friable Particles (max. %) g/	1.0	1.0
Soft particles (max. %) a/	5	5
Sticks or roots (max. %) a/	0.5	0.5

- a/ Applies to each source except as noted.
- b/ Applies to the combined aggregate except as noted.
- c/ Applies to the aggregate retained on the No. 4 sieve.
- d/ Applies to the combined coarse aggregate.
- e/ The coarse aggregate used in the asphalt concrete surface course, shoulders and detours excepted, shall contain not less than 30 percent insoluble residues.
- f/ A flat or elongated piece is one in which the length is greater than five times the average thickness.
- g/ Applies to the combined aggregate. Provided the maximum for the combined aggregate is not exceeded, a maximum 1.5 percent will be allowed for any one source.

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708.03 ASPHALT MATERIALS.

- A. *General.*** Bituminous materials shall meet the requirements shown in Tables 2A through 2E for the type and grade of asphalt material specified.
- B. *Handling.*** The handling, loading, hauling, transfer pumping or similar operations connected with the movement of bituminous materials shall be in compliance with the requirements of the manufacturer, and/or the Engineer. If at any time materials furnished for use under these Specifications fail to produce satisfactory results, further shipments will be rejected. The material will not be accepted for further work until the producer satisfies the Engineer that the material has been so corrected as to produce satisfactory results.
- C. *Application Temperature.*** The temperature to which asphalt materials shall be heated at the time of use shall be as shown in Table 2E, unless otherwise specified.

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TABLE 2A

**REQUIREMENTS FOR ASPHALT CEMENT GRADED BY VISCOSITY AT 140° F
(Grading based on original asphalt)**

Asphalt cement shall be prepared from crude petroleum by suitable methods, shall be homogeneous, free from water, and shall not be heated to 347° F.

TEST	VISCOSITY GRADE			
	AC-3.5	AC-7.5	AC-10	AC-20
Viscosity, 140° F, poises	350 + 70	750 + 150	1000 + 200	2000 + 400
Viscosity, 275° F, Cs-minimum	145	215	250	300
Penetration, 77° F, 100 g. 5 sec.	220-300	110-160	80-125	60-100
Flash Point, COC, ° F minimum	350	400	425	450
Solubility in trichloroethylene, percent minimum	99.0	99.0	99.0	99.0
Test on residue from Rolling Thin-Film Oven Test:				
Loss on heating, percent-maximum		1.0	1.0	1.0
Viscosity, 140° F, poises-maximum	1500	3000	4000	8000
Ductility 77° F, 5 cm per minute, cm-minimum	100 a/	100	75	5
Spot test with Standard Naptha Solvent	Negative for all grades			

a/ If ductility is less than 100, the material will be accepted if its ductility at 60° F is 100 minimum.

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TABLE 2B REQUIREMENTS FOR CUT-BACK ASPHALT (MEDIUM CURING TYPE)										
Cut-back asphalt shall be produced by fluxing an asphalt base with suitable petroleum distillates, shall show no separation or curdling prior to use, and shall not foam when heated to application temperature.										
	MC-30		MC-70		MC-250		MC-800		MC-3000	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Kinematic Viscosity at 140° F Centistokes	30	60	70	140	250	500	800	1600	3000	6000
Flash Point (Tag, open-cup), degrees F	100		100		150		150		150	
Water percent Distillation test: Distillate percentage by volume of Total distillate to 680° F		0.2		0.2		0.2		0.2		0.2
to 437° F		25	0	20	0	10			0	15
to 500° F	40	70	20	60	15	55	0	35	0	15
to 600° F	75	93	65	90	60	87	45	80	15	75
Residue from distillation to 360° C 680° F Volume percentage of sample by difference	50		55		67		75		80	
Tests on residue from distillation: Absolute viscosity at 140° F, Poises	400	1200	400	1200	400	1200	400	1200	400	1200
Ductility, 5 cm/min., cm. a/	100		100		100		100		100	
Solubility in Trichlorethylene, percent	99.0		99.0		99.0		99.0		99.0	
Standard Naptha	Negative for all grades									

a/ If the ductility at 77° F is less than 100, the material will be acceptable if its ductility at 60° F is more than 100.

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TABLE 2C REQUIREMENTS AND TYPICAL APPLICATIONS FOR EMULSIFIED ASPHALT										
The emulsified asphalt shall be homogeneous. Within 30 days after delivery and provided separation has not been caused by freezing, the emulsified asphalt shall be homogeneous after thorough mixing.										
Type Grade	Rapid-Setting				Medium-Setting					
	RS-1		RS-2		MS-1		MS-2		MS-2h	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Tests on emulsion:										
Viscosity, Saybolt Furol at 77° F, s	20	100			20	100	100		100	
Viscosity, Saybolt Furol at 122° F, s			150	400 c/						
Storage stability test, 24-h, %		1		1		1		1		1
Demulsibility, a/ 35 ml., 0.02 N CaCl ² Q, %	60		60							
Coating ability and water resistance					Good Fair		Good Fair		Good Fair	
Coating Retention										
Sieve Test, %		0.10		0.10		0.10		0.10		0.10
Residue by distillation, %	55		63		55		65		65	
Tests on residue from distillation test:										
Viscosity, 140° F, poises d/	400	1200	400	1200	400	1200	400	1200	1600	4800 d/
Penetration, 77° F, 100 g, 5a	100	200	100	200	100	200	100	200	40	90
Ductility, 77° F, 5 cm/min, cm	40		40		40		40		40	
Solubility in trichloroethylene, %	97.5		97.5		97.5		97.5		97.5	

Typical applications b/:

For RS-1: Surface treatment, penetration macadam, sand seal coat, tack coat, mulch.

For RS-2: Surface treatment, penetration macadam, coarse aggregate seal coat (single and multiple).

For MS-1: Cold plant mix, road mix, sand seal coat, crack treatment, tack coat.

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For MS-2: Cold plant mix, coarse aggregate seal coat (single and multiple), crack treatment, road mix, tack coat, sand seal coat.

For MS-2h: Cold plant mix, hot mix, coarse aggregate seal coat (single and multiple), crack treatment, road mix, tack coat.

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TABLE 2C (CONTINUED)													
TYPE	HIGH FLOAT								SLOW SETTING				
	HFMS-1		HFMS-2		HFMS-2H		HFMS-2s		SS-1		SS-1h		
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
Tests on emulsions:													
Viscosity, Saybolt Furol at 77° F, s	20	100	100		100			50		20	100	20	100
Viscosity, Saybolt Furol at 122° F, s													
Storage stability test, 24-h, %		1		1		1		1		1		1	
Coating ability and water resistance:													
Coating Retention	Good Fair		Good Fair		Good Fair		Good Fair		Good Fair		Good Fair		
Cement mixing test, %									2.0			2.0	
Sieve test, %	0.10		0.10		0.10		0.10		0.10		0.10		
Residue by distillation, %	55		65		65		65		57		57		
Tests on residue from distillation test:													
Viscosity, 140° F, poises	400	1200	400	1200	1600	4800 d/	200	600	400	1200	1600	4800 d/	
Penetration, 77° F 100 g, 5 s	100	200	100	200	40	90	200		100	200	40	90	
Ductility, 77° f, 5 cm/min., cm	40		40		40		40		40		40		
Solubility in trichloroethylene, %	97.5		97.5		97.5		97.5		97.5		97.5		
Float test, 140° F, s	1200		1200		1200		1200						
Typical application b/: HFMS-1: Cold plant mix, road mix, sand seal coat, crack treatment, tack coat. HFMS-2: Cold plant mix, coarse aggregate seal coat (single and multiple), crack treatment, road mix, tack coat, and seal. HFMS-2h: Cold plant mix, hot plant mix, coarse aggregate seal coat (single and multiple), crack treatment, road mix, tack coat. HFMS-2s: Dense-graded cold plant mix and road mix, stockpile mix, crack treatment, patching mix. SS-1 & SS-1h: Cold plant mix, road mix, slurry seal coat, tack coat, fog seal, dust layer, mulch.													

a/ The demulsibility test shall be made within 30 days from date of shipment.

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- b/ These typical applications are for use only as a guide for selecting and using the emulsion for pavement construction and maintenance.
- c/ Maximum viscosity at the point of manufacture shall be 500 seconds. The viscosity at the job site shall be from 100 to 400 seconds.
- d/ Variability will be limited to + 600 poises from the target value established by the manufacturer.

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**TABLE 2D
REQUIREMENTS AND TYPICAL APPLICATIONS FOR CATIONIC EMULSIFIED ASPHALT**

The emulsified asphalt shall be homogenous. Within 30 days after delivery and provided separation has not been caused by freezing, the emulsified asphalt shall be homogeneous after thorough mixing.

TYPE GRADE	Rapid-Setting				Medium-Setting				Slow-Setting				
	CRS-1		CRS-2		CMS-1		CMS-2		CSS-1		CSS-1h		
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
Tests on emulsions:													
Viscosity, Saybolt Furol at 77° F, s										20	100	20	100
Viscosity, Saybolt Furol at 122° F, s	20	100	150	400 d/	50	500	50	450					
Storage stability test, 24-h, % a/	1		1		1		1		1		1		
Demulsibility, a/ 35 ml 0.8% Sodium diocetyl Sulfosuccinate %	40		40										
Classification test	Passes		Passes										
Coating ability and water resistance:													
Coating					Good		Good		Good		Good		
Coating Retention					Fair		Fair		Fair		Fair		
Particle charge test	Positive		Positive		Positive		Positive		Positive b/		Positive b/		
Sieve test, %		0.10		0.10		0.10		0.10		0.10		0.10	
Cement mixing test, %										2.0		2.0	
Distillation:													
Oil distillate, by volume of emulsion, %		0.1		0.1		8		12					
Residue, %	60		65		65		65		57		57		
Test on residue from distillation test:													
Viscosity 140° F, poises	400	1200	400	1200	f/		400	1200	400	1200	1600	4800 a/	
Penetration, 77° F, 100 g., 5 s 100	250	100	250	300		100	250	100	250	40	90		
Ductility, 77° F, 5 cm/min., cm	40		40		40		40		40		40		

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Solubility in trichloroethylene, %	97.5		97.5		97.5		97.5		97.5		97.5	
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Typical applications c/:

- CRS-1: Surface treatment, penetration macadam, sand seal coat, tack coat, mulch.
- CRS-2: Surface treatment, penetration macadam, coarse aggregate seal coat (single and multiple).
- CMS-1: Cold plant mix, road mix, hot mix-cold lay.
- CMS-2: Cold plant mix, coarse aggregate seal coat (single and multiple), crack treatment, road mix, tack coat, sand seal coat.
- CSS-1 & Css-1h: Cold plant mix, road mix, slurry seal coat, tack coat, fog seal, dust layer, mulch.

- a/ The 24 hour storage stability test results do not necessarily predict satisfactory 5-day settlement test results.
- b/ If the particle charge test result is inconclusive, material having a maximum pH value of 6.7 will be acceptable.
- c/ These typical applications are for use only as a guide for selecting and using the emulsion for pavement construction and maintenance.
- d/ Maximum viscosity at the point of manufacture shall be 500 seconds. The viscosity at the job site shall be from 150 to 400 seconds.
- e/ Variability will be limited to + 600 poises from the target value established by the manufacturer.
- f/ The Saybolt Furol viscosity of the residue shall be 200-600 seconds when tested at 180° F (82° C).

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TABLE 2E SUGGESTED TEMPERATURES FOR USE OF ASPHALT MATERIALS			
TYPE OR GRADE OF ASPHALT	MIXTURE AT AT DISCHARGE MAX. °f	ASPHALT TEMPERATURE	
		FOR MIXING °F	FOR SPRAYING °F
AC-20	350	275-350	285-350
AC-10	325	275-325	285-350
AC-7.5	325	275-325	285-350
AC-3.5	325	240-290	260-325
MC-30		50-120	50-120
MC-70		80-150	80-150
MC-250	200	100-200	100-200
MC-800	210	160-210	185-260
MC-3000	250	200-250	225-275
ALL EMULSIONS		50-160	50-160

708.04 COMPOSITION °F MIXTURES.

- A. Asphalt Mix Design and Initial Job-Mix Formula.** The asphalt mix design and initial job-mix formula are the responsibility of the Contractor and shall be submitted to the Engineer for approval.

The mix design shall be prepared in a laboratory of the Contractor's choice.

The initial job-mix formula shall meet the requirements of Table 3A or 3B and Table 4 for the type mix specified on the Plans or in the Proposal.

The Engineer may require the Contractor to prepare a trial mixture to confirm the initial job-mix formula.

If the trial mixture, prepared at the initial job-mix formula proportions, fails to meet the requirements of Table 4, the Contractor may propose changes to the job-mix formula. If these changes do not result in a mixture meeting the requirements of Table 3A or 3B and Table 4, the Engineer will require a new mix design.

If the changes do result in a mixture meeting these Specifications, the job-mix formula will be adjusted accordingly.

The job-mix formula shall establish a single percentage of aggregate passing each required sieve, a single percentage of asphalt to be contained in the mixture, and a single temperature of the mixture at point of discharge from the plant.

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For all mixtures the job-mix formula with allowable tolerances shown in Table 5 shall establish the specification limits for that mixture. These limits may be outside the broad range given in Table 3A or 3B except for the absolute maximum size sieve. (For example, the absolute maximum size sieve for asphalt concrete, Type C is the ½ inch sieve.)

B. Plant Produced Mixtures. The plant produced mixture shall be a uniform mixture of the combined aggregate and asphalt and shall conform to the requirements of Table 4 and the specification limits established by the job-mix formula with allowable tolerances.

After the plant is in operation, the Contractor may propose adjustments to the job-mix formula within the limits shown in Table 3A or 3B. If test results indicate these adjustments will result in a mixture meeting the requirements of Table 4, the job-mix formula will be adjusted accordingly.

Should a change in sources of materials be made, a new job-mix formula shall be established before the new material is used. When unsatisfactory results or other conditions make it necessary, the Engineer will require a new job-mix formula.

The job-mix formula for asphalt is the target value. Every effort shall be made by the Contractor to incorporate that amount of asphalt into the mixture irregardless of the allowable tolerances.

For temporary construction, such as crossovers and detours, the requirements given in Table 3A for minimum percent asphalt and Table 4 for retained strength and V.M.A. will be waived.

C. Recycled Bituminous Pavements. Bituminous mixtures containing up to 40 percent reclaimed asphalt concrete pavement (RACP) will be accepted, except in the wearing course, providing all the requirements of these Specifications are met.

The following table shall be used in selecting the viscosity grade asphalt cement to be used in recycling the RACP:

PENETRATION OF RECOVERED ASPHALT CEMENT	ALLOWABLE PERCENTAGES OF RACP	
	FOR AC-20	FOR AC-10
0-22	0-20	21-40
23-27	0-25	26-40
28-32	0-30	31-40
33-37	0-35	36-40
38 and up	0-40	(Not Permitted)

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TABLE 3A - TABLE OF MIXTURES (Hot Mix – Hot Lay)				
Mixture:	Asphalt Concrete			
Open Graded Type:	A	B	C	D
	i/	i/	i/	a/
Sieve Size	Percent Passing			
1-1/2"	100			
1"	90-100			
3/4"		100		
1/2"	70-90	90-100	100	
3/8"		70-90	90-100	
No. 4	40-65	45-70	60-80	80-100
No. 10	25-45	25-50	35-60	50-90
No. 40	10-26	12-30	15-35	20-50
No. 80	6-18	7-20	8-22	10-30
No. 200	See j/	See j/	See j/	5-15
% AC Soluble in Solvent c/	3.8-6.5	4.7-7.5	5.1-7.5	5.5-7.5
Viscosity Grade Asphalt Cement	AC-20	AC-20	AC-20	AC-20

TABLE 3B - TABLE OF MIXTURES (Hot Mix – Cold Lay)				
Gradation Size:	HC1	HC2	HC3	HC4 a/
Sieve Size:	Percent Passing d/ e/ f/ g/			
1-1/2"	100			
1"	90-100			
3/4"		100		
1/2"	70-90	90-100	100	
3/8"		70-90	90-100	100
No. 4	40-65	45-70	60-80	80-100
No. 10	25-45	25-50	35-60	50-90
No. 40	10-26	12-30	15-35	20-50
No. 80	6-18	7-20	8-22	10-30
No. 200	3-6	4-7	4-8	5-15
Asphalt Type c/	MC-800	MC-800	AC 3.5 or MC-800	MC-800 or CMS-1 Emulsion

Footnotes for Tables 3A & 3B

- a/ Shall be a blend of at least 75 percent crushed stone with a maximum of 25 percent sand.
- c/ Expressed as a percent of total mix weight. Lower limit may be adjusted if the effective specific gravity of the combined aggregates is greater than 2.65. This adjustment will only be allowed if the lab molded specimens meet the VMA requirement at 4 percent air voids.

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Footnotes for Tables 3A & 3B, Continued:

- d/ If emulsion or MC grade asphalt is used, the aggregate shall be surface dry and heated to a temperature above 160° F.
- e/ AC Type Mixtures. The aggregate shall be thoroughly dried and delivered to the mixer at a temperature above 200° F and not higher than the temperature of the asphalt binder. Water, not exceeding 3 percent and primer not exceeding 1.2 percent of the aggregate by weight, shall be added as necessary to assure the required workability of the mixture. The quantity of water and primer added to the aggregate shall be accurately controlled by a meter or other suitable measuring device. Except as otherwise requested by the Engineer, the workability of the mixture shall be suitable for stockpiling and use at ambient temperatures.
- f/ The temperature of the aggregate shall not be heated in excess of the temperature of the liquid asphalt at time of mixing.
- g/ MC-3000 may be substituted for MC-800 when specified or approved by the Engineer.
- h/ The job-mix formula for percent AC in the open-graded friction course is calculated by the following equation:
$$\% \text{ AC (16.5)} / (\text{Effective Specific Gravity } 0.165)$$
- i/ If the ADT is 2,500 or more, the total amount of natural sand and gravel shall not exceed 15 percent of the combined aggregate. For ADT less than 2,500, the natural sand and gravel shall not exceed 25 percent of the combined aggregate.
- j/ For Types A, B, and C asphalt concrete, the ratio of the percent passing the No. 200 sieve to the percent asphalt cement shall be a minimum of 0.6 to a maximum of 1.2. This ratio will establish the master range for the job-mix formula on the No. 200 sieve. The job-mix formula, with allowable tolerances, will establish a specification range which may be outside the master range.

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TABLE 4 – PROPERTIES OF LABORATORY MOLDED SPECIMENS		
Mixture Property	Asphalt Concrete	Hot Mix Cold Lay
Density, % of max. theo. sp. gr.		
5000 ADT or More	94-96	93-97
1000 to 5000 ADT	95-97	93-97
1000 ADT or less	96-98	93-97
Hveem Stability, min, 2500 ADT ore more a/	40	35
Less than 2500 ADT	35	35
% Retained Strength min. for 2500 ADT or more	75	NA

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	ASPHALT CONCRETE			
	Type A	Type B	Type C	Type D
V.M.A. min. % b	13	15	16	17

- a/ Includes all City streets.
- b/ V.M.A. (Voids in the Mineral Aggregate) is based on the effective specific gravity of the aggregates.

708.05 TOLERANCES. The tolerances shown in Table 5 shall be applied to the job-mix formula (JMF) as described in Subsection 708.04.

The job average for gradation shall meet the state tolerances. An individual sample will be allowed 1-1/2 times the tolerance shown for gradation, providing adjustments are made and the subsequent sample is within the stated tolerance.

TABLE 5 – RANGE OF TOLERANCES (PERCENT)		
Passing Sieve Size	Asphalt Concrete	Asphalt Surf. Course (HM-CL)
No. 4 & larger	+7	+7
No. 10	+4	+5
No. 40	+4	+4
No. 80	+4	+4
No. 200	+2	+2
Asph. Soluble in solvent	+0.4c/	+0.5c/
Temp. of mix as discharged from mixer °F	+20	+20

- c/ The tolerances shown for asphalt content are for individual samples. The average asphalt content, by extraction, shall be within +0.2 percent of the job-mix formula.

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708.06 SAMPLING AND TESTING.

A. Methods. Sampling and testing shall be done in accordance with AASHTO Methods, except as noted below:

1. *Sampling and Testing Aggregates:*

Sampling	T 2
Sieve Analysis	T 27
Material Passing No. 200 Sieve	T 11
Wear (Los Angeles Abrasion)	T 96
Mud, Clay Balls, Sand Clusters, Sticks and Roots, Retained No. 4 Sieve	OHD L-9
Fractured Faces	OHD L-18
Sand Equivalent	T 176
Durability Factor (Plastic Fines in Aggregates)	T 210
Insoluble Residue	OHD L-25
Soft Particles	OHD L-38

2. *Sampling and Testing Bituminous Mixtures:*

Mechanical Analysis of Extracted Aggregate	T 30
Sampling a/	T 168
Bitumen Content	OHD L-26
Recovery of Asphalt from Solution by Abson Method	T 170
Maximum Specific Gravity of Bituminous Paving Mixtures	T 209
Bulk Impregnated Specific Gravity of Aggregates b/	OHD L-7
Compacting Materials for Stabilimeter Value (Texas Gyrotory)	OHD L-8
Specific Gravity and Wg. Per C.F. of Compressed Bituminous Mixture	OHD L-14
Test for Stabilimeter Value (Hveem)	OHD L-16
Retained Strength	OHD L-36

a/ The sample size of compacted bituminous pavement shall be in accordance with T 166.

b/ OHD L-7 shall only be used when the results obtained from AASHTO T 209 are suspect.

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3. *Testing Asphalt Materials:*

Absolute Viscosity	T 202
Kinematic Viscosity	T 201
Saybolt Furol Viscosity	T 72
Penetration	T 49
Flash Point	T 48
Solubility in Trichloroethylene	T 44
Thin Film Oven Test	T 179
Ductility	T 51
Spot Test	T 102
Water	T 55
Rolling Thin Film Oven Test	T 240
Distillation	T 78
Flash Point	T 79
Testing Emulsified Asphalt	T 59
pH of Aqueous Solutions with the Glass Electrode	T 200
Coating & Retention Testing for Mixing Grade Emulsions	T 59 Modified
Specific Gravity by Pycnometer	T 228
Specific Gravity by Hydrometer	ASTM D3142

- B. *Method and Procedure for Sampling Bituminous Materials.*** Sampling of bituminous materials shall be in accordance with AASHTO T 40, except that the method at the project site or mixing plant shall be in accordance with OHD L-5.

The producers of the bituminous materials shall be furnished with the correct project designation and instructed that such designation shall be used in connection with all materials shipped on the project. Sampling will be done at the point of manufacture whenever the quantity shipped will warrant such procedure and samples may also be taken at the point of destination. Bituminous materials shall not be used until approved by the Engineer.

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709.00 ELECTRICAL CONDUIT

Description. This Section covers the requirement of materials for electrical conduit of the size, type and at the locations shown on the Plans or established by the Engineer in Section 802.

709.01 METALLIC CONDUITS.

- A. *Rigid Steel.*** Rigid galvanized steel conduit, intermediate metallic tubing, electrical metallic tubing and rigid aluminum conduit shall comply with AASHTO M 272.
- B. *PagFlexible Steel.*** Liquid-tight flexible steel conduit and fittings shall comply with the requirements of UL-360.

709.02 NON-METALLIC CONDUITS.

- A. *Rigid Plastic.*** Rigid plastic conduit shall comply with the requirements of AASHTO M 272.
- B. *Flexible Plastic.*** Flexible plastic conduit shall comply with the requirements of NEMA TC7 and shall be smooth wall coilable duct of high density polyethylene (HDPE) meeting the requirements of ASTM D 1248, Type III Class C, Grade P33, Category 5, Schedule 40, unless otherwise specified in the Plans.
- C. *Cable-in-Duct.*** Cable-in-duct conduit shall be factory assembled. The duct shall be HDPE and comply with paragraph B. above and be the size shown on the Plans. The conductors shall be of the type, size and number shown on the Plans. Identification of the conductor shall be accomplished by color coding the insulation by means of a continuous longitudinal colored stripe or various solid colors of continuous longitudinal colored stripe or various solid colors of insulation, in addition to the standard conductor markings.

709.03 OUTLET BOXES, FITTING AND ENTRANCE CAPS.

- A. *General.*** Outlet boxes, fitting and entrance caps shall comply with current industry standards, and be compatible with the conduit material used.
- B. *Fittings.*** Fittings and cement used with plastic conduit shall be compatible with the conduit material.

709.04 TESTING. Conduit may be accepted on the project without testing provided it is visually inspected and all pieces are clearly labeled with the UL label or a Type D certification is furnished by the manufacturer.

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710.00 DELINEATORS

Description. This Section establishes the requirements for materials and tests for delineators in Section 853.

710.01 REFLECTORS.

- A. General.** Reflectors that are mounted on a post to form a delineator unit shall be circular and provided with a single mounting hole through the center. The mounting hole shall have an inside diameter of 0.188 inch to 0.203 inch. The reflector shall have the capacity of accommodating a 3/16 inch nominal diameter blind rivet expanded to 0.196 inch without fracturing. The center mount reflectors may or may not be fabricated with an aluminum housing.
- B. Delineators.** Delineators shall consist of reflectors as specified herein, mounted on galvanized steel posts when installed on roadway shoulders, galvanized steel posts installed on guard rail posts or galvanized steel posts and brackets installed on bridges.
- C. Acrylic Plastic Reflector.** The reflector shall be acrylic plastic methyl methacrylate, meeting requirements of Federal specifications L-M-5002, Type 1, Class 3.

Reflectors shall consist of a crystal (colorless), amber or red transparent face with a minimum dimension of 3 inches and not less than 7 square inches of reflective area, herein referred to as the lens, with a heat sealable acrylic plastic or heat sealable metal foil back fused to the lens under heat and pressure around the entire perimeter of the lens and the central mounting hole to form a unit permanently sealed against water and water vapor. The embossed aluminum housing shall have a thickness of 0.02 + 0.002 inches. The center mount reflectors without aluminum housing shall be backed by a vapor-tight, hermetically sealed plastic backing to prevent vapor and dust from reaching the reflex surface.

The lens shall consist of a smooth front surface free from projection or indentation other than a central mounting hole and identification with a rear surface bearing a prismatic configuration such that it will effect total internal reflection of light. The manufacturer's name or trademark shall be molded legibly into the face of the lens.

D. Definitions.

1. Incidence angle shall mean the angle at reflector between direction of light incident on it and direction of reflector's axis.
2. Divergence angle shall mean the angle at reflector between observer's line of sight and direction of light incident on the reflector.

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3. Specific intensity shall mean candlepower returned at the chosen divergence angle by a reflector for each foot-candle of illumination at the reflector.

E. Specific Intensity. The specific intensity of each reflex reflector intended for use as delineators or markers shall be equal to or exceed the following minimum values regardless of reflector orientation.

Divergence Angle Degrees	Incidence Angle Degree	Specific Intensity Candlepower Per Foot-candle		
		Crystal	Amber	Red
1/10	0	119	71	29
1/10	20	47	28	11
1/3	0	20	12	5
1/3	20	8	5	2

F. Specific Intensity Test. Specific intensity will be determined in accordance with Federal Test Method Standard 370.

Failure to meet the specific intensity minimum shall constitute failure of the reflector being tested. Failure of more than 4 percent of the reflectors subjected to test shall constitute failure of the lot or shipment except that when 25 or less samples are submitted, failure of more than one reflector subjected to test shall constitute failure of the lot or shipment.

G. Seal Test. The following test shall be used to determine whether a reflector is completely sealed against dust and water: Submerge the samples in a water bath at room temperature. Subject the submerged samples to a vacuum of 5 inches of mercury for 5 minutes. Restore atmospheric pressure and leave sample submerged for 5 minutes, then examine the samples for water intake. Failure of more than 4 percent of the number tested shall be cause for rejection.

H. Sampling. The sample reflectors required for optical and seal tests will be selected at random. The number of reflectors required for a sample are as indicated in the schedule below:

Quantity in Shipment or Lot	No. of Reflectors required for Sample
100 or less	3
100 to 800	3 percent
800 to 5000	25 to 50
5000 and over	1 percent

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710.02 POSTS.

- A. *Galvanized Steel Delineator Posts.*** This item shall consist of furnishing, cutting, drilling, punching, fabricating, and galvanizing a finished channel-type or hat-type delineator post, according to these requirements and the Plans.

The galvanized channel-type post shall be fabricated from 1-1/2 x 1/2 x 1/8 inches steel bar channel, cut to the specified length, and drilled, or punched, as required, suitable for mounting the approved type delineator and installed on guard rail posts when so intended. The basic steel channel employed in the fabrication shall meet dimensional tolerances for the specified size above according to Table 28 of ASTM A 6 for bar size shapes less than 3 inches.

An alternate galvanized steel hat section type post may be used. It shall be rolled from sheet steel to the dimensions and shape shown on current Department standard drawings. The alternate post shall weigh 1.12 pounds + 3.5 percent per linear foot before galvanizing.

It shall be the Contractor's responsibility to furnish the correct size fasteners required for the type post used, unless otherwise shown on the Plans.

All cutting and hole drilling or punching shall be accomplished prior to galvanizing.

The posts shall receive a 2 ounce zinc coating according to ASTM A 123.

- B. *Testing.*** One or more samples will be required for determination of zinc coating, according to ASTM A 123, and compliance with dimensional requirements required by ASTM A 6 and these Specifications.

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711.00 TRAFFIC STRIPE

Description. This Section establishes the requirements for materials and tests for thermoplastic compounds, preformed plastic tapes, traffic stripe paint and glass beads.

711.01 THERMOPLASTIC COMPOUNDS.

- A. **Hot Applied Thermoplastic Compound Materials.** The hot applied thermoplastic compound shall meet the requirements of AASHTO M 249. The binder component shown in Section 4.2, Table 1 Composition, shall be made of hydrocarbon material unless otherwise specified on the Plans. Each shipment of the product shall be accompanied by a Type A Certification as specified in Subsection 106.12.

711.02 PERMANENT PAVEMENT MARKING TAPE.

- A. **General.** The plastic striping tape as supplied shall be of good appearance, free from cracks, and edges shall be true, straight and unbroken. The material shall be available in rolls and there shall be no more than 3 splices per 50 yards of length.

Preformed words and symbols shall conform to the applicable shapes and sizes as outlined in the current Manual on Uniform Traffic Control Devices for Streets and Highways.

The plastic striping tape shall be packaged in standard commercial containers so constructed as to insure acceptance by the carrier and prevent damage during shipment and storage.

The plastic striping tape as supplied shall be capable of retaining required properties when stored at temperatures up to 100° F for periods up to one year.

A Type A Certification shall be furnished in accordance with Subsection 106.12.

The plastic striping tape shall conform to the following requirements:

1. **Composition.** The retroreflective, preformed pavement marking film shall consist of high quality plastic materials, pigments and glass beads uniformly distributed throughout its cross-sectional area and with a retroreflective layer of glass beads firmly bonded on the top surface. The preformed plastic film shall be pre-coated with a pressure-sensitive adhesive that is compatible with bituminous concrete and portland cement concrete road surfaces.

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2. *Skid Resistance.* The surface of the retroreflective preformed film shall provide a minimum skid resistance value of 35 BPN when tested in accordance with ASTM E 303.
3. *Thickness.* The thickness of the preformed plastic film without adhesive for lane and edge lines shall be not less than 0.060 inch and not more than 0.090 inch.
4. *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, except that a sample 6 inch x 1 inch 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 percent at break when tested by this method.
5. *Conformability.* The preformed film shall be capable of conforming to pavement contours, breaks and faults through the action of traffic at normal pavement temperatures. The preformed plastic film shall have characteristics such that it is capable of fusing with itself and previously applied marking film of the same composition under normal conditions of use.
6. *Removability.* The plastic striping tape shall be designed as not to be easily removed after application.
7. *Adhesive.* The plastic striping tape for longitudinal and transverse markings shall have pressure-sensitive backing without liner. Word and symbol tape shall have pressure-sensitive backing with protective liner.
8. *Application Properties.* The material shall adhere to asphalt and concrete surfaces when applied according to manufacturer's recommendations at surface temperature of 65° F and rising. If the markings must be applied when the surface temperature is below 65° F, but not below 50° F, the markings are to be applied in strict accordance with the manufacturer's recommended procedures and/or other special instructions.
9. *Glass Beads.* Glass beads shall be incorporated by the manufacturer 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.
10. *Pigmentation.* Color pigments shall be thoroughly blended to provide a pavement marking film that maintains uniform color under both daylight and night lighting conditions throughout the expected life of the film.

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White pavement marking film shall be similar to Federal Standard Color No. 595-17886. Yellow pavement marking film shall be similar to Federal Standard Color No. 595-13538.

11. *Reflectance.* The white and yellow films shall have the following initial minimum reflectance values of 0.2° and 0.5° 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. The test distance shall be 50 feet and the sample size shall be a 2.0 x 2.5 foot rectangle.

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 reference center shall be taken perpendicular to the test sample.

	White		Yellow	
Observation Angle	0.2°	0.5°	0.2°	0.5°
SL (mcd ft ⁻² fc ⁻¹)	550	380	410	250

12. *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. The tape must be qualified by a State Highway or Transportation Department. 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.

711.03 TEMPORARY PAVEMENT MARKING TAPE.

- A. General.** The traffic striping material shall consist of a white or yellow weather and traffic resistant reflective film on a conformable backing pre-coated with a pressure-sensitive adhesive. Satisfactory performance test of not less than 12 months conducted by a State Highway or Transportation Department shall qualify the material.

The striping tape shall be white or yellow as specified. The white and yellow striping tape shall be retro reflective, reflecting white or yellow respectively and shall be readily visible when viewed with automobile headlights at night.

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The striping tape shall have a pre-coated pressure-sensitive adhesive which shall not require a liner for protection from contamination, pre-adhesion, or blocking within the roll or require activation procedures.

The material shall adhere to asphalt and concrete surfaces when applied according to manufacturer's recommendations at surface temperatures down to 35° F and shall require no protective devices such as traffic cones or barricades.

- B. Conformability.** The striping material shall be thin, flexible, and formable, and following application shall remain conformed to the texture of the pavement surface.

The average thickness of the material, as determined by five micrometer readings, will not be less than 15 mils nor more than 45 mils.

- C. Durability and Wear Resistance.** The striping material applied in accordance with manufacturer's recommended procedures shall be weather-resistant and show no appreciable facing, lifting or shrinkage during the useful life of the line.

- D. Packaging.** The striping material shall be packaged in standard commercial containers so constructed as to insure acceptance by the carrier and prevent damage during shipment and storage.

- E. Storage.** The striping material as supplied shall be capable of being stored at temperatures up to 100° F for periods up to one year without deterioration.

- F. Certification.** A Type D Certification shall be required for the temporary pavement marking tape in accordance with Subsection 106.12.

711.04 REMOVABLE PAVEMENT MARKING TAPE.

- A. General.** Removable pavement marking tape shall consist of a white or yellow all-weather traffic resistant film on a reinforced conformable backing, pre-coated with a pressure-sensitive adhesive. Glass beads shall be uniformly distributed throughout the film for retro reflectivity.

- B. Adhesive.** The removable, pre-formed pavement marking film shall be pre-coated with a pressure-sensitive adhesive capable of being adhered to asphalt concrete and portland cement concrete pavement surfaces without the use of heat, solvents, additional adhesives or activators and shall be immediately ready for traffic after application. The adhesive shall be capable of bonding to pavement surfaces when applied at temperatures of 50° F and above without pickup or distortion by vehicular traffic.

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- C. Color.** The material shall be white or yellow, as specified, conforming to the standard highway color requirements of the Manual on Uniform Traffic Control Devices.
- D. Glass Beads.** The glass beads shall be colorless and shall have a minimum refraction index of 1.50 when tested using the liquid immersion method. The size and quantity of beads shall be such that retro reflectivity of the pre-formed film is maintained as the film wears through the surface course.
- E. Removability.** The pre-formed pavement marking film shall be removable from asphalt concrete and portland cement concrete pavement intact or in substantially large strips, either manually or by a mechanical roll-up device, at temperatures above 50° F, and without the use of heat, solvents, grinding or sandblasting.
- F. Durability.** 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. The tape must be pre-qualified by a satisfactory performance test of at least 6 months conducted by a State Highway or Transportation Department. The removability characteristics must also be demonstrated to meet the requirements of this section through the above-described performance test. 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.
- G. Certification.** A Type D Certification shall be required for the removable pavement marking tape in accordance with Subsection 106.12.

711.05 TRAFFIC STRIPE PAINT – TYPE I. The white and yellow traffic paint shall be suitable for spray application and use as a reflecting traffic guide on concrete and bituminous highway pavements. It is the intent of these Specifications to provide both general and composition requirements in sufficient detail to assure a quality paint capable of providing satisfactory reflectorized traffic lines.

The paint shall be of a type in which the glass beads are dropped on the pigmented binder during application (hereinafter designated as binder type) so that, upon drying, the paint line is capable of retro direction of the headlight beams from vehicles. The term paint is herein construed as pigmented binder.

- A. Materials.** Condition and Stability. The paint shall be homogeneous, shall be well-ground to a uniform and smooth consistency, and shall not skin or settle badly, or cake, liver, thicken, curdle, or gel in the container. The paint shall be capable of being broken up and mixed without difficulty by use of a paddle and shall show the desired characteristics at any time within a period of 6 months from date of delivery.

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- B. *Drying Time.*** The paint, when applied to either portland cement concrete or bituminous surfacing at a rate of .015 inch thickness (wet film), shall be sufficiently dry within ½ hour after application so that there will be no pickup under traffic and shall be thoroughly dry and free from tackiness within 40 minutes after application when the atmospheric temperature is a minimum of 77° F and the relative humidity if between 25 and 50 percent.
- C. *Viscosity.*** The paint as received shall have a consistency as determined by the Stormer Viscosimeter at 77° F of 68 to 80 Krebs Units. Any paint which changes consistency within 6 months after receipt so that the consistency falls outside the viscosity limits stated above shall be considered to have failed this test.
- D. *Colors.*** The white and yellow colors for traffic making paint shall conform to the standard highway color code requirements of the Manual of Uniform Traffic Control Devices for Streets and Highways.
- E. *Bleeding.*** The paint shall not show bleeding sufficient to impair the color and visibility of the paint when applied to a suitably prepared and cured bituminous surface. The pigmented binder shall be tested in accordance with Federal Specification TT-P-85b and shall have a minimum bleeding ration of 0.95 when tested.
- F. *Foreign Matter.*** The paint shall be free from skins, dirt and other foreign matter, and shall contain not more than one percent water. (Methods 4081, 4091, and 4902.1, Federal Specification TT-P-141a).
- G. *Composition Requirements. Proportioning.*** The various components shall be proportioned by weight as set forth below:

PIGMENTED BINDER	WHITE (percent)	YELLOW (percent)
1. Pigment:	59.0 Min.	55.5 Min.
Titanium Dioxide (ASTM D 476 Type III)	18.0 Min.	3.2 Min.
Medium Chrome Yellow		14.7 Min.
Talc (ASTM D 605)	25.5 max.	42.3 Max.
Mica (Water Ground) ASTM D 607	7.0 Max.	
Calcium Carbonate (Particulate size range 0.5-10.0 microns)	49.7 Max.	40.7 Max.
2. Vehicle:	41.0 Max.	44.5 Max.
Medium Oil Alkyd Resin Solids 1/	37.8 Min.	37.9 Min.

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VM&P Naptha (IBP 200° F Min.; DP 290° F Max.)	60.0 Max.	59.9 Max.
Driers and Additives	2.8 Max.	3.5 Max.
3. Binder Constants:		
Viscosity @ 77° F	68-80 KU	68-80 KU
Fineness	2.5 Min. N.S.	2.5 Min. N.S.
Dry Time ASTM D 711 (Minutes)	No pick-up 40 Max.	No pick-up 40 Max.
Wgt. Per Gal. @ 77° F	12.25 lb. Min.	11.80 lb. Min.
Skinning in 48 hours; ¾ full tightly capped container	None	None
1/ Alkyd Resin Linseed Oil or Soya Oil		50 Min.
Phthalic Anhydride		33 Min.
Acid No.		10 Max.
Color (G-H)		9 Max.
Resin, Phenolic, Petroleum Resins		Negative
Solvent		VM&P Naptha

H. Containers. The paint shall be furnished in container size as specified in the Contract. Where 55 gallon containers are specified, they shall be new, standard, round, 18-gage drums with either bung type lids or have a removable and re-sealable drum head as specified in the Contract. Containers shall also meet Federal requirements.

All containers shall be labeled with the following information:

1. The City of Edmond
2. Specification Type
3. Purchase Order Number (if applicable)
4. Manufacturer's Name
5. Date of Manufacture
6. Manufacturer's Batch Number

Labels must be sufficiently weather-resistant to withstand outside storage for a minimum of one year.

I. Inspection, Sampling and Testing. All sampling shall be in accordance with Subsection 730.01 B.

J. Sealed Shipments. Shipments shall be sealed in accordance with Subsection 730.01 C.

711.06 TRAFFIC STRIPE PAINT – TYPE III (DROP ON). The white and yellow traffic paints shall conform on a weight basis to the composition of the standard formula as closely as accepted good paint practice will permit. No

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variation from the standard formula will be permitted except for replacements or volatiles lost in processing or those approved by the Engineer.

A. Materials.

1. *Substitutions.* The exact brands and types of raw materials are listed for the purpose of facilitating the selection of parallel material equal not only in quality and composition, but also in physical and chemical behavior after aging in the finished product. Since evaluation of questionable materials may require 60 days after receipt of request from a paint manufacturer, the Contractor is reminded that he should schedule material procurement to permit him to meet delivery commitments. The final decision as to quality of materials shall be made by the Engineer. After the Engineer has approved the brand names of raw materials proposed by paint manufacturer, no substitution will be allowed during manufacture without prior approval of the Department of Transportation.

2. *Pigment.*
 - a. Pure Titanium Dioxide Rutile, Type II, shall meet ASTM Specification D 476-73.
 - b. Lead Free Zinc Oxide: American Process, Acicular, shall meet Federal Specification TT-P-463a, Type I.
 - c. Talc, Paint Grade Magnesium Silicate, shall meet Federal Specification MIL-M15173, Type B.
 - d. Calcium Carbonate:

CaCO ₃	Min. 97 percent
H ₂ O Max.	0.4 percent
Specific Gravity	2.63 – 2.73
Fineness Requirements 80 percent less than 5u (microns).	
 - e. Medium Chrome Yellow ASTM D 211, Type III.
 - f. Feldspar, water washed alkali aluminum silicate, Lawson-United LU-340.

Color: Equal to material listed in standard formula. Substitution in a standard formula shall not result in a viscosity greater than 5 KU.

3. *Resins.*

a. *Traffic Paint Alkyd Resin Solution:*

1. General:

Type:	Pure, drying alkyd
Length:	Medium
Type Oil:	Soya, linseed or tall. No mixture of two or more oils will be permitted.
Solvent:	Toluol, ASTM Specification D 362

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Compatibility: A solution of one part 75 percent traffic alkyd and five parts toluol shall be clear.

A solution containing the equivalent of 120 grams of 20 cps chlorinated rubber, 130 grams of 75% traffic alkyd, 200 grams of methyl ethyl ketone shall be clear transparent, and show no separation after 24 hours of storage in a $\frac{3}{4}$ full test tube at 80° + 5° F. This rubber-alkyd solvent solution shall produce a clear film upon drying.

2. Solid Resin Basis:	Percent
Phthalic Anhydrides	33 to 37
Percent Oil Acids	48 to 55
Acid Number, Max.	8.0
Ash Residue, Max.	0.10%
Unsaponifiable, Max.	2.0%
Iodine Number of Fatty Acids, Min.	115
Refractive Index of Fatty Acids, Min.	1.4660
Percent Rosin based on Fatty Acids (Tall Oil Alkyds), Max.	1.0

3. 45% Solid Basis:

Color:	Gardner 1953 Standard-9 Max.
Drying Time:	A wet film 3 mils thick shall set to touch in not more than 90 minutes.
Dryers:	Based on the resin solids present, add the equivalent of 0.06% Cobalt (metal) and 1.0% Lead (metal).

Toluol shall be used to reduce the resin solution to 45% solids, and shall meet ASTM Specification D 362.

b. *Chlorinated Paraffin:* Shall meet Federal Specification MIL-C-429A, Type I.

c. *Chlorinated Rubber:*

Appearance:	Free flowing white powder
Viscosity (20 percent w/w in Toluene) (ASTM D 115)	0.018 – 0.222 pas @ 25° C
Chlorine, percent by weight (TT-P-115c 4.3.6)	Minimum 64.5
Ash, percent by weight	Maximum 0.20
Solubility	Soluble in aromatic hydrocarbons, eg., toluene, xylene, and alkylated benzenes.

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4. *Thinners.*

a. Methyl Ethyl Ketone Federal Spec. TT-M-26

5. *Additives.*

a. Anti-settling Agent Bentone 34 or Claytone 40
b. Stabilizer Thermolite 813.

B. Composition Requirements. The various components shall be proportioned by weight as set forth below:

1. *Paint, Traffic:*

	WHITE (pounds)	YELLOW (pounds)
Medium Chrome Yellow		85
Titanium Dioxide, Rutile Type II	100	25
Lead Free Zinc Oxide	25	50
Talc	250	100
Feldspar - LU390		125
Calcium Carbonate	275	250
Anti-settling Agent	5	5
Traffic Alkyd 75% solids	130	130
Chlorinated Rubber 20CPS	105	120
Chlorinated Paraffin	85	75
36% Lead Drier	1.5	1.5
12% Cobalt Drier	0.5	0.5
Anti-skinning Agent	2	2
Thermolite 813	0.5	0.5
Methyl Alcohol	5	6
Methyl Ethyl Ketone	207	270
Toluene	53	
Xylene	10	
TOTAL	1254.5	1245.5
TOTAL GALLONS	99.272	98.592
WEIGHT PER GALLON	12.637	12.633

2. *Properties of Finished Paint:*

- a. Weight per gallon + 0.25 lbs. of theoretical gallon weight
- b. Consistency @ 25° C (Krebs-Stormer) 75-85 KU
- c. Drying Time: ASTM D711 maximum 5 minutes
- d. Bleeding: Fed. Spec TT-P-85d 4.3.11 0.95 minimum
- e. Dry Opacity: Fed. Test Std. 0.91 minimum
No. 141a Method 4121 using wet film of approx. 4 mils.

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- f. Daylight Reflectance: Fed. Test Std. 80% White
No. 141a Method 6121 50% Yellow
- g. Fineness of grind (Hegman) 3 minimum
- h. Skinning: The paint shall show no skinning after
48 hours in a ¾ filled tightly closed container.
- i. Color: Yellow dry film shall be in compliance
with Highway Yellow Color Chart U.S. Dept.
of Transportation, Federal Highway Administration

3. *Percent Composition Requirements:*

	WHITE	YELLOW
Percent Total Solids	75.0 + 2%	74.5 + 2%
Percent Pigment	52.2 + 2%	51.4 + 2%
Percent Vehicle	47.8 + 2%	48.6 + 2%
Percent Non. Vol. (Veh./Veh.)	45.5% Minimum	4.5% Minimum

Upon chemical analysis of pigments and vehicle solids, the percentages must be within reasonable manufacturing tolerances as determined by the Engineer.

- 4. *Containers.* Containers shall meet the requirements of Subsection 711.05 H.

711.07 GLASS BEADS FOR TRAFFIC PAINT. Glass beads used for thermoplastic compound and traffic stripe paint shall meet the requirements of AASHTO M 247, Type I with the exception that the average crushing resistance when tested in accordance with OHD L-12 shall be not less than the following:

PASSING SIEVE	RETAINED SIEVE	CRUSHING STRENGTH
No. 20	No. 30	25 lbs.
No. 30	No. 40	15 lbs.

Beads shall be supplied with a moisture-resistant coating.

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712.00 CONSTRUCTION FABRICS

Description. This Section covers fabrics to be used for reinforcement of asphalt pavements and filter fabric for various uses.

712.01 FABRIC REINFORCEMENT FOR ASPHALT CONCRETE PAVEMENT.

- A. General.** The fabric shall be an approved paving-grade, fused on one side, non-woven, needle-punched, material constructed of long chain synthetic polymers composed of at least 85 percent polyesters, polyolefins or polyamides by weight.
- B. Test Requirements.** The reinforcement fabric shall meet the following test requirements:

TESTS	LIMIT	TEST METHOD
Weight	3-6 oz/sq yd	ASTM D 2646
Tensile Strength (Grab Method)	90 lbs minimum	ASTM D 1682
Elongation at break	55% minimum	ASTM D 1682
Asphalt Retention	0.20 gal/sq yd minimum	ODOT Procedure

- C. Packaging and Storing.** The fabric shall be supplied by the manufacturer in rolls of standard widths and lengths uniformly wound onto suitable cylinder forms or cores to aid in handling and unrolling by the use of mechanical laydown equipment. Rolls supplied shall provide full coverage of the payment with a minimal number of joint splices.

Rolls of fabric shall be furnished with a suitable type wrapping for protection against sunlight and moisture. When stored outdoors, the rolls shall be elevated and covered with a tarpaulin.

- D. Sampling and Testing.** The Contractor shall furnish a Type A Materials Certification for the reinforcement fabric in accordance with Subsection 106.12.

712.02 FILTER FABRIC FOR GABIONS.

- A. General.** Filter fabric shall be a pervious sheet of non-woven fibers. The fabric shall be constructed of long chain synthetic polymers, composed of at least 85 percent polyesters, polyolefins or polyamides by weight. The fabric shall provide an equivalent opening size (EOS) no finer than U.S. Standard sieve No. 100 and no coarser than U.S. Standard Sieve No. 50. The EOS of the filter fabric shall be determined in accordance with the U.S. Army Corps of Engineers method. The fabric shall be fixed so that the fibers will retain their relative position to each other. The fabric shall be free of defects, flaws,

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chemical treatments or coats which significantly affect its physical and/or filtering properties.

- B. Test Requirements.** The filter fabric shall conform to the following physical property requirements:

TEST	REQUIREMENT	METHOD (CURRENT SPECIFICATION)
Thickness (Min.)	15 Mils	ASTM D 1777
Weight (Min.)	3.9 oz./sq. yd.	ASTM D 2646
Tensile Strength (Min.)	100 lbs.	ASTM D 1682 Grab Test Method 1 inch square jaws and a travel rate of 12 inches per minute
Elongation, %	45-150 %	ASTM D 1682 (Same Method as for Tensile Strength)
Puncture Strength	40 lbs.	ASTM D 751 Tension Testing Machine with ring clamp; steel ball replaced with a 5/16 inch diameter solid steel cykubder with a hemispherical tip centered with a ring clamp
Ultraviolet Degradation at 150 hours	70% Retained Strength (Minimum)	ASTM D 4355

- C. Acceptance.** The Contractor shall furnish a Type D Material Certification for the fabric in accordance with Subsection 106.12.

712.03 GEOTEXTILES FOR SUBSURFACE DRAINAGE PURPOSES.

- A. General.** This Subsection covers geotextiles to be used in conjunction with pipe underdrain and other drainage systems. The fabric shall meet the requirements of AASHTO M 288.

- B. Acceptance.** The Contractor shall furnish a Type D Material Certification for the fabric in accordance with Subsection 106.12.

712.04 FILTER FABRIC FOR USE WITH RIPRAP.

- A. General.** This Subsection describes a pervious fabric to be used under riprap for slope protection. The fabric shall be an approved non-woven, needle-punched material constructed of long chain synthetic polymers composed of at least 85 percent polyester, polyolefins or polyamides.

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B. Test Requirements. The fabric shall meet the following test requirements.

TEST	MINIMUM REQUIREMENT	METHOD
Weight	6 oz. sq/yd	ASTM D 2646
Thickness	70 mils	ASTM D 1777
Grab Strength	180 lbs.	ASTM D 1682
Puncture Strength	75 lbs.	ASTM D 751 a/
Burst Strength	290 psi	ASTM D 751 b/
Trapezoidal Tear Strength	50 lbs. c/	ASTM D 1117
Ultraviolet Degradation at 150 hours	70% Retained Strength	ASTM D 4355
E.O.S.	50-100	d/

- a/ Tension Testing Machine with ring clamp, steel ball replaced with a 5/16 inch diameter solid steel cylinder with a hemispherical tip centered within the ring clamp.
- b/ Diaphragm Test Method.
- c/ Either principal direction.
- d/ Determined by the U.S. Army Corps of Engineer Method.

C. Acceptance. The Contractor shall furnish a Type D Material Certification for the fabric in accordance with Subsection 106.12.

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713.00 STONE FOR RIPRAP, FILTER BLANKET AND GABIONS

713.01 MATERIALS COVERED. This Section covers stone for plain riprap, laid up riprap or grouted riprap, stone for special plain riprap and materials for filter blanket and gabions.

713.02 RIPRAP STONE. General. Stone for riprap shall be hard, sound and durable and shall be approved by the Engineer prior to use.

Tests for weight and absorption will be determined in accordance with ASTM C 97. The minimum weight shall be 140 pounds per cubic foot and the maximum absorption shall be 6 percent.

Soundness (freeze and thaw test) loss of the stone after 20 cycles shall not exceed 15 percent when tested in accordance with the Corps of Engineers test method CRD-C 144.

The size of stone for the various kinds of riprap shall be as follows:

A. Stone for Plain Riprap.

RIPRAP THICKNESS (INCHES)	MAXIMUM (POUNDS)	AVERAGE SIZE (POUNDS)	NOT MORE THAN 20% SHALL WEIGH LESS THAN
12	150	30-50	20 lbs.
18	350	70-125	30 lbs.
24	1000	225-400	40 lbs.
30	1000	225-400	40 lbs.

When placed on the embankment the smaller stones shall be well-distributed throughout the mass. Neither the breadth or the thickness of any piece of riprap shall be less than 1/3 of its length.

B. Stone for Laid-up or Grouted Riprap.

RIPRAP THICKNESS (INCHES)	SIZE RANGE (POUNDS)	AT LEAST 60% SHALL WEIGH MORE THAN
12	50-250	100 lbs.
18	50-500	150 lbs.

Slabs of silver will be rejected. Spalls shall be well-graded of a suitable size for the work.

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C. Stone for Special Plain Riprap.

40 percent to 60 percent	5 c.f. to 12 c.f. in volume
20 percent to 30 percent	2 c.f. to 5 c.f. in volume
10 percent to 20 percent	0.25 to 2 c.f. in volume
5 percent to 15 percent	may be less than 0.25 c.f. in volume

713.03 FILTER BLANKET MATERIAL. Material for a filter blanket shall consist of sand, gravel, crushed stone, or other approved materials processed, blended, or naturally combined. It shall be reasonably free from lumps or balls of clay, organic matter, objectionable coatings, or other foreign materials, and shall be durable and sound. Blanket material shall not contain flat and/or elongated particles in an amount exceeding 20 percent. A flat or elongated piece is one in which the length is greater than 5 times the average thickness. The backing material in place shall be reasonably well-graded within the following limits:

SINGLE COURSE BACKING (FILTER BLANKET)	
SIEVE DESIGNATION U.S. STANDARD SQUARE MESH	PERCENT BY WEIGHT PASSING
4"	100
2"	60-90
1"	40-70
3/8"	15-40
No. 4	0-15

TWO COURSE BACKING (FILTER BLANKET)		
SIEVE DESIGNATION U.S. STANDARD SQUARE MESH	PERCENT BY WEIGHT PASSING	
	LOWER COURSE OF TWO LAYERS	UPPER COURSE OF TWO LAYERS
6"	---	100
4"	---	90-100
2"	---	65-85
1"	---	40-70
3/8"	100	15-35
No. 4	95-100	0-10
No. 8	80-90	---
No. 16	55-75	---
No. 30	30-60	---
No. 50	12-30	---
No. 100	0-10	---

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713.04 GABIONS.

A. Gabion Materials.

1. *Wire Baskets.* Gabion baskets shall meet the requirements of Subsection 732.09.
2. *Rock Fill.* Rock fill for the gabion baskets shall consist of hard, dense, sound, durable, rough fractured stone as nearly cubical as practicable. No rock shall have a minimum dimension less than 4 inches, nor have a maximum dimension greater than 8 inches. Rock shall have a specific gravity of not less than 2.5.

B. Filter Fabric. The filter fabric shall conform to the requirements of Subsection 712.02.

C. Filter Sand. Filter sand shall meet the requirements of Subsection 703.04 B.

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714.00 MASONRY BRICK

Description. This Section covers the requirements for masonry brick (manufactured from either concrete or clay or shale). The particular type will be specified on the Plans or in the Proposal, and shall comply with the requirements set out below for each type.

714.01 MASONRY BRICK MADE FROM CLAY OR SHALE.

- A. General Construction Brick.** Masonry brick of this type shall comply with the requirements of AASHTO M-114 for building brick. Unless otherwise shown on the Plans, grade MW brick shall be used.
- B. Sewer and Manhole Brick.** Manhole brick shall comply with AASHTO M 91, grade MM for manholes, junction boxes and other appurtenances.

714.02 CONCRETE BUILDING BRICK. Concrete building brick shall conform to the requirements of ASTM C 55. Unless otherwise shown on the Plans, either Type I, Grade S-I or Type II, Grade N-II shall be used.

Concrete brick shall not be used in the construction or reconstruction of sanitary sewer manholes.

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716.00 BITUMINOUS DAMP-PROOFING AND WATERPROOFING MATERIALS

Description. This Section covers bituminous primer and mop coats for use, when specified, in damp-proofing and waterproofing below or at ground level, for application to concrete and masonry surfaces.

716.01 ASPHALT PRIMER. Asphalt primer for use with asphalt for waterproofing or damp-proofing shall meet the requirements of AASHTO M 116.

716.02 CREOSOTE PRIMER. Creosote primer for use with tar for waterproofing shall meet the requirements of AASHTO M 121.

716.03 ASPHALT CEMENT. Asphalt cement for waterproofing or damp-proofing shall meet the requirements of AASHTO M 115, Type II.

716.04 COAL-TAR PITCH. Coal-tar pitch for waterproofing shall meet the requirements of AASHTO M 118.

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717.00 MISCELLANEOUS WATERPROOFING MATERIALS

717.01 ASPHALT FELT.

A. *Description.* This Subsection covers rag felt saturated with an asphalt, for use in the membrane system of waterproofing.

B. *General Requirements.* Rag felt shall be produced by felting vegetable and animal fibers. Saturation shall be accomplished by passing the dry felt in single thickness through the saturant at a temperature and speed that will not injure the felt and then calendaring it between heated cylinders. It shall then be cooled and wound into rolls.

The surface of the felt shall be uniformly smooth, and upon splitting or tearing on the bias, shall appear reasonably free from lumps or under-beaten stock; i.e., stock that has not been beaten or shredded into fiber in a process of manufacture and from particles of foreign substance such as fragments of stone, metal, leather, rubber, straw, wood, etc.

Felt shall be saturated thoroughly and uniformly and shall show no unsaturated spots at any point upon cutting 2 inch strips at random across the entire sheet and splitting them open for their full length.

The finished felt shall be free from visible defects, such as holes, ragged or untrue edges, breaks, rents or cracks, and shall not be coated or covered with talc or other substance that will interfere with adhesion between the felt and the bitumen.

Rolls of felt shall be wrapped securely or tied to prevent unrolling in transit. It shall be of such quality that it may be unrolled easily at atmospheric temperatures above 50° F without injury from sticking.

Felt shall be delivered to the work in the original packages bearing the manufacturer's brand and label. The kind of material and purpose for which it is to be used shall be indicated on the label.

C. *Detailed Requirements.* Rag felt shall meet the requirements of ASTM D 226.

717.02 BITUMINOUS TREATED FABRIC.

A. *Description.* This Subsection covers cotton fabric uniformly and thoroughly saturated with asphalt, for use in the membrane system of waterproofing. The material shall meet the requirements of AASHTO M 117.

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717.03 PLASTIC CEMENT.

A. Description. Plastic cement shall be composed of semi-solid asphalt dissolved in a suitable volatile solvent and stiffened with a mineral filler consisting essentially of short, incombustible, mineral fibers.

B. General Requirements. The asphalt forming the base of the plastic cement shall be refined petroleum asphalt with a penetration at 77° F of 30-70. The mixture shall meet the following requirements:

Asphalt, percent by weight	38+
Mineral Filler, percent by weight	25+
Petroleum Solvent, percent by weight	25-

Plastic cement shall be of such consistency that it can be spread readily with a trowel without drawing or pulling, or can be extruded through a suitable nozzle under a minimum pressure of 50 pounds per square inch.

When applied in a layer 1/16 to 1/8 inch thick, plastic cement shall set within 24 hours to a tough plastic coating free from blisters.

After drying for 72 hours, a patch of plastic cement 1/16 to 1/8 inch thick, applied to the material upon which it is to be used, shall not blister or sag more than ¼ inch upon exposure at a temperature of 140° F for 5 hours.

After drying for 72 hours and exposure at a temperature of 140° F for 5 hours, a patch of cement 1/16 to 1/8 inch thick shall be plastic and adhere well to fabric, saturated felt, metal or concrete, upon exposure at a temperature of 32° F for one hour.

After drying for 24 hours and exposure at a temperature of 140° F for 24 hours, and then cooling to a temperature of 70° to 77° F a patch of the cement 1/16 to 1/8 inch thick shall not crack or break from the saturated fabric, saturated felt, or metal, when bent over a mandrel one inch in diameter.

717.04 INSULATING PAPER. Insulating paper shall be a waterproof paper 36 inches wide, weighing not less than 10 pounds per 100 square feet.

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719.00 SIGNS.

Description. This Section establishes the requirements for materials for signs in Section 850.

719.01 PANELS.

A. Aluminum.

1. *Sheet Aluminum.* Sheet aluminum signs shall be ASTM B 209 alloy 6061-T6 or 5052-H38 with mill finish. Thickness, dimensions, hole sizes, and hole locations shall be shown on the Plans. All panels shall be flat and straight within commercial tolerances established by the aluminum industry.

Sheet aluminum signs shall be treated with a chromate type chemical conversion coating in accordance with ASTM B 449, Class II.

2. *Extruded Aluminum.* Extruded aluminum panel signs shall be ASTM B 221 alloy 6063-T6. Thickness, dimensions, hole sizes and hole locations shall be as shown on the Plans. All panels shall be flat and straight within commercial tolerances established by the aluminum industry. The extruded aluminum shall be free of corrosion, white rust and dirt.

Type A edge strip shall be aluminum ASTM B 221 alloy 6063-T6. Aluminum Type B sheet metal screws with slotted pan heads shall be placed on 24-inch centers maximum to secure the edge strips to the sign panels. On signs with width of 36 inches or less, a minimum of three screws shall be used.

- B. Galvanized Steel.** Galvanized sheet steel sign material for flat or formed steel panel signs and edge strips shall be galvanized steel sheet, Physical (Structural) Quality ASTM A 446, Grade A, Coating Designation G90. Material used for flat sheet signs shall be stretcher leveled. Thickness, dimensions, hole sizes and hole locations shall be as shown on the Plans. Galvanizing shall not be done until the sign material has been cut to the proper size and shape and all required bolt holes punched. Holes for fastening letters, symbols, borders and edge strip may be drilled after galvanizing. The steel sign material shall be free of ragged or sharp edges and shall be free of corrosion, rust and dirt.

- C. Sign Faces.** All sign faces are to be made in accordance with the detailed drawings as shown in the latest revision of the Manual on Uniform Traffic Control Devices for Streets and Highways, and/or as shown on the Plans.

- D. Basis of Acceptance.** A Type A or B Certification is required for acceptance of sign panels, extrusions and shapes covered in this Section.

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719.02 SUPPORT ARMS AND FITTINGS.

- A. *Materials.*** Sign supports for sheet signs shall be structural steel conforming to AASHTO M 183 or aluminum alloy conforming to ASTM B 221 alloy 6063-T6. Structural steel signs shall be galvanized in conformance with AASTHO M 111 after being cut to length and after all required holes are punched or drilled. Thickness, dimensions, hole sizes and hole locations shall be as shown on the Plans.
- B. *Fabrication.*** Fabrication of all signs, bracket arms and fittings shall be accomplished in a uniform and workmanlike manner. All fabrication, including cuttings, shearing and punching, shall be completed prior to metal degreasing, etching and application of reflective sheeting. All parts shall be cut to size and shape and shall be free of buckles, warp, dents, cockles, burrs, and all defects resulting from fabrication.
- C. *Basis of Acceptance.*** A Type A or B Certification is required for acceptance of material in this Section.

Galvanization will be determined by a sample or coupon test specimen galvanized in accordance with AASTHO M 111, Section 8.

719.03 FASTENERS.

- A. *Aluminum Signs.*** Sheet and extruded aluminum. Bolts for fastening sheet aluminum signs to sign bracket arms shall be aluminum fasteners and collars of the size shown on the Plans.

Panel bolts, hex nuts, post clip bolts, stop nuts and flat washers shall be aluminum ASTM B 209 alloy 2024-T4. Extruded aluminum signs shall be attached to posts on each side as shown on the Plans with post clip, post clip bolt and nut and flat washer. Flat washers shall be used under each nut to prevent gouging.

- B. *Galvanized Steel Signs.*** Sheet and panel steel signs shall be mounted by use of galvanized bolts, nuts and washers of the size and types shown on the Plans.

719.04 REFLECTIVE AND NON-REFLECTIVE SHEETING.

- A. *Description.*** Reflective sheeting used in the fabrication of reflectorized sign faces shall be of types as follows:

Type A. Enclosed lens type consisting of spherical lens elements embedded beneath the surface of a smooth transparent, flexible plastic, resulting in a non-exposed lens, optical reflecting system.

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Type B. Encapsulated lens type consisting of spherical lens elements adhered to a synthetic resin and encapsulated by a flexible, transparent waterproof plastic having a smooth surface.

All reflective sheeting shall be of the Type A Classification unless otherwise required by Plan details or the Proposal.

Non-reflective sheeting shall consist of a smooth, flat, durable gloss plastic film.

All sheeting shall be weather-resistant and have a pre-coated adhesive backing protected by a removable liner.

B. Requirements.

1. *Photometric.* Type A Material Requirements for Type A Reflective Sheeting shall be in accordance with the provisions of Federal Specification L-S-300 for Type 1, Class 1 or 2 and Reflectivity Level 1 and the requirements further noted in this Specification.

Type B Material Requirements for Type B Reflective Sheeting shall be in accordance with the provisions of Federal Specification L-S-300 (latest revision) for Type 1, Class 1 or 2, Reflectivity Level 2, and the requirements further noted in this Specification. Material requirements for non-reflective sheeting shall be the same as that prescribed for reflective sheeting except for the reflectivity requirements and the material shall have a gloss reading of 50 to 70 units at an angle of 45° when measured with a photo voltmeter or a meter capable of giving equal results.

2. *Color.* The chromaticity limits of the colors shown in L-S-300 Table 1, shall be modified to conform to the requirements of the Federal Highway Administration color charts for the colors covered by the tolerance charts.
3. *Tests and Samples.* The Contractor shall furnish a certified test report confirming compliance with the requirements noted hereinbefore in this Specification.

Verification of color by comparison of samples with color tolerance charts published by the FHWA shall be made on all samples. Noticeable variation of color in a production run shall be cause for ordering inspection of all sign faces and the rejection of any sign face outside of the tolerances provided by the color tolerance charts.

All testing shall be in accordance with Federal Specification L-S-300.

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All completed signs shall be inspected on the project by the Engineer. Faulty application, blemishes or other faults that might impair the serviceability of the sign or any noticeable color mismatching when viewed from a distance of 25 feet under both daylight and night time conditions shall be cause for rejection of any sign face.

719.05 SIGN COPY.

A. Screen Copy.

1. *Direct Screening Process.* The direct screening process may be used for applying non-reflectorized copy on reflectorized or non-reflectorized backgrounds. This method is normally applicable to black copy.
2. *Reverse Screening Process.* The reverse screening process shall be used to provide reflectorized messages on colored backgrounds by the use of transparent color stencil paste applied to a sheeting background of silver white color. This method is normally applicable to a requirement for white copy, for example, "STOP" sign.
3. *Material and Application.* Material for application by the silk screen method shall be a top quality exterior baking screen enamel or stencil paste manufactured especially for use on roadway signs and compatible with the type sign background material being used. Application of screened copy and curing thereof shall be in strict compliance with the manufacturer's recommendations of the background material.

Colors shall be durable and consistent with the requirements of the FHWA Standards Colors Charts for Signs. The color shall be uniform in acceptable hue when viewed in daylight or under normal headlights at night.

4. *Final Finish.* All of the above-mentioned signs shall be treated after completion as prescribed in Subsection 850.04 D.
5. *Tests.* All screening enamel, stencil pastes and process inks when applied in accordance with recommended procedure and exposed to accelerated weathering for 1000 hours in accordance with Federal Test Method 141/6151 shall show no appreciable discoloration, cracking, crazing, blistering or lifting.

719.06 DEMOUNTABLE REFLECTORIZED AND NON-REFLECTORIZED CUTOUT LETTERS, NUMERALS, ARROW, SYMBOLS AND BORDERS.

- A. **General.** Demounted reflectORIZED legend, symbols and borders shall consist of acrylic plastic prismatic reflectors supported by embossed aluminum frames. The prismatic reflectors are to be installed in the embossed aluminum frames

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so as to be an integral part of the character, or otherwise securely affixed to prevent their displacement in handling or service. Copy in which reflectors are assembled by means of tape are unacceptable. Demountable non-reflectorized legend, symbols, and borders shall consist of embossed aluminum without plastic reflectors.

Letter design shall be in accordance with the 1966 FHWA standard alphabets (as revised) or other approved standards, modified to accommodate the required reflectors. All items shall be fabricated from sheet aluminum having a minimum thickness of 0.040 inch.

Mounting holes shall be provided within the frames to permit the use of an approved fastener. The size and spacing of reflector holes for reflectorized legend and borders shall be such as to afford maximum night legibility and visibility of the finished cutout figure. There shall be no reflector holes for non-reflectorized legend and borders. After metal fabrication has been completed, the finishing process shall be as follows:

- B. *Reflectorized Legend and Borders.*** Aluminum frames shall be degreased, etched, neutralized and treated with an amorphous chromate coating in accordance with ASTM D 1730.

After treating, frames shall be finished with a high-quality baking enamel which shall be applied in strict accordance with the recommendations of the manufacturer. The color shall be white or black as specified on the Plans.

- C. *Non-reflectorized Legend and Borders.*** Aluminum legend and borders shall be degreased, etched, neutralized and treated with an amorphous chromate coating in accordance with ASTM D 1730. After treating, legend and borders shall be finished with baking enamel, to be applied in strict accordance with the recommendations of the manufacturer. The color of the non-reflectorized legend and borders shall be as shown on the Plans.

D. *Prismatic Reflectors.*

1. *General.* The reflector lens shall be Methyl Methacrylate meeting requirements of Federal Specifications L-M-500a, Type I, Class 3.

The reflector shall consist of a clear and transparent plastic face, herein referred to as the lens, and an opaque or translucent back fused to the lens under heat and pressure around the entire perimeter to form a unit permanently sealed against dust, water and water vapor. The reflector shall be basically colorless.

The lens shall consist of a smooth front surface free from projections or indentations other than for identification or orientation of the reflector. The rear surface shall have a prismatic configuration such that it will

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affect total internal reflection of light. The manufacturer's trademark shall be molded legibly into the face of the lens.

2. *Optical Requirements.*

2.1 *Definitions.* Incidence angle shall mean the angle at reflector between direction of light incident on it and direction of reflector axis.

Divergence angle shall mean the angle at reflector between observer's line of sight and direction of light incident on reflector.

Specific brightness shall mean candlepower returned at the chosen divergence angle by a reflector per square inch of reflecting surface for each foot-candle of illumination at the reflector.

2.2 *Specific Brightness.* The specific brightness of each reflex reflector intended for use in cutout letters, symbols and accessories shall be equal to or exceed the following minimum values with measurements made with reflectors spinning.

DIVERGENCE ANGLE DEGREES	INCIDENCE ANGLE DEGREES	SPECIFIC BRIGHTNESS CANDLEPOWER/SQUARE INCH/FOOT-CANDLE
1/10°	0°	14.0
1/10°	20°	5.6

2.3 *Optical Testing.* The specific brightness shall be determined in accordance with Federal Test Method 370.

Failure to meet the specific brightness minimum shall constitute failure of the reflector being tested. Failure of more than 4 percent of the reflectors subjected to test shall constitute failure of the shipment. In samples of less than 25 reflectors, failure of more than one reflector shall constitute failure of the shipment.

3. *Durability.*

3.1 *Seal Test.* The following test will be used to determine whether a reflector is complete sealed against dust and water.

Submerge the samples in water bath at room temperature. Subject the submerged samples to a vacuum of 5 inches of mercury for 5 minutes. Restore atmospheric pressure and leave samples submerged for 5 minutes; then examine the samples for water intake. Failure of more than 4 percent of the reflectors tested shall be cause for rejection of the shipment or lot. In samples of less than

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25 reflectors, failure of more than one reflector shall constitute failure of the shipment.

3.2 Three assembled cutout letters, symbols or accessories shall withstand the combined corrosion test set forth in ASTM B 117.

E. Sampling Procedure. Samples of the reflectorized legend, consisting of letters, numerals, border and symbols will be selected at random to obtain equitable representation of the various size groups according to the stock quantities involved.

The sample of reflectorized legend shall provide sufficient reflectors of each size for compliance with the following schedule:

QUANTITY OF EACH SIZE REFLECTOR	NUMBER OF REFLECTORS PROVIDED BY SAMPLE
100 or less	3
100 to 800	3 percent
800 to 5000	25 to 50
5000 and over	100

F. Packaging. Each cutout figure shall be supplied in an individual package with content marked thereon.

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721.00 GALVANIZED STEEL SIGN POSTS

Description. This Section establishes the requirements for galvanized steel sign posts in Section 851.

A Type A or Type B Certification will be required. Galvanized specimens shall be submitted for testing in accordance with Section 8, AASHTO M 111.

721.01 PIPE POSTS. Galvanized steel pipe posts shall be made from new galvanized steel pipe of the size shown on the Plans and shall conform to ASTM A 53. When the wall thickness or weight is not designated, standard weight pipe, Schedule 40, shall be used. Galvanizing shall be done after fabrication and punching or drilling of holes that may be permitted on the Plans, except as provided herein. Cap plates shall be structural steel, AASHTO M 183 galvanized in accordance with AASHTO M 111 or other materials when shown on the Plans.

Sign posts used for signs that are minor items or incidental construction, when approved by the Engineer, may be fabricated and holes drilled or punched after galvanizing provided that the exposed metal surfaces shall be re-galvanized, metalized or painted with an approved zinc dust-zinc oxide paint.

721.02 WIDE FLANGE BEAM POSTS. Galvanized steel wide-flanged beams shall be new material of the size shown on the Plans and shall conform to the requirements of AASHTO M 183. Galvanizing shall be in accordance with AASHTO M 111 and shall be done after punching or drilling of any holes or cutting that may be permitted by the Plans or by the Engineer.

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723.00 REINFORCING STEEL

723.01 BAR STEEL REINFORCEMENT – (BILLET STEEL). This Specification covers plain and deformed billet steel bars for concrete reinforcement and dowels used in the work. The billet steel bars shall meet the specification requirements of AASHTO M 31, Grade 40 or Grade 60. Reinforcing steel bars of structural Grade 60 shall be furnished when specified and shown on the Plans.

Sampling. A sample shall consist of two bars, not less than 24 inches in length, from each lot of bars in the shipment. The chemical analysis report shall be furnished with each lot. The term lot used in this paragraph means all bars of one size bearing one manufacturer's roll mark.

723.02 AXLE STEEL. This Specification covers deformed and plain axle steel bars for concrete reinforcement and dowels which may be used in lieu of those as specified in Subsection 723.01. Axle steel bars shall meet the Specification requirements of AASHTO M 53, Grade 40 or Grade 60. Reinforcing steel bars for structural Grade 60 shall be furnished when specified and shown on the Plans.

Sampling shall conform to Subsection 723.01 above except that the carbon range for each lot will be required in lieu of a full chemical analysis.

723.03 WELDED STEEL WIRE FABRIC. These Specifications cover cold drawn steel wire to be used as such, or in fabricated form, for the reinforcement of concrete.

The fabric shall comply with the requirements of AASHTO M 55 or AASHTO M 221. The size and spacing of wires in the fabric shall be as shown on the Plans. Welds shall be of sufficient strength that they will not be broken during handling or placing.

Reinforcing fabric shall be furnished in flat sheets or rolls. Any material that may have become bent or distorted must be straightened and otherwise put in proper condition before using. When placed in the work, the fabric shall be free from excessive rust, scale, or coating of any character which will impair its bond with the concrete.

723.04 STEEL WIRE STRAND FOR PRE-STRESSING. Steel for pre-stressing shall conform to the Specifications for Uncoated Seven-Wire Stress-Relieved Strand for Pre-Stressed Concrete, AASHTO M 203 except that Type A Certification shall be furnished for each reel or coil of strand included in the work.

723.05 BARS FOR POST-TENSIONING. Bars shall be high-strength alloy steel bars meeting the requirements of AASHTO M 275. A Type A Certification shall be furnished for each heat of material.

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723.06 POST-TENSIONING STEEL WIRE. Steel cable for post-tensioning shall conform to the Specifications for Uncoated Stress-Relieved Wire for Pre-Stressed Concrete, AASTHO M 204, Type BA or WA. A Type A Certification shall be furnished for each coil of wire.

When low-relaxation wire is specified, it shall meet the requirements of the supplement to AASHTO M 204.

723.07 ANCHORAGES FOR POST-TENSIONED TENDONS. All anchorages shall be capable of de-tensioning or re-tensioning pre-stressing steel at any time prior to grouting. The load from the anchoring device shall be distributed to the concrete by means of approved devices.

Anchorage shall develop the specified ultimate strength of the tendons without exceeding anticipated set.

Bending stresses in the plates or assemblies induced by the pull of the pre-stressing steel shall not exceed the yield point of the material. All parts of the anchoring devices will be at least 2 inches inside the final end surfaces of the members. A Type A certification shall be furnished for each heat of anchorage plates.

723.08 COLD DRAWN STEEL WIRE. Cold drawn steel wire for concrete reinforcement for spiral ties and other reinforcing designated on the Plans in W (Wire) sizes shall comply with AASHTO M 32.

723.09 EPOXY-COATED REINFORCING BARS. Description.

These Specifications cover organic protective coatings electrostatically applied to steel bars to be used for concrete reinforcement.

A. Materials. Epoxy-coated reinforcing bars and epoxy coating material shall meet the requirements of AASHTO M 284 Specifications, except as otherwise stipulated under these Specifications.

1. *Reinforcing Steel.* Reinforcing steel bars shall meet the requirements of Subsections 723.01 or 723.02.
2. *Coating Materials.* Coating materials proposed for use shall be approved by the Engineer.
3. *Color.* The finished epoxy coating shall be of a color and tone that will give easily apparent visual indications of holidays, damage or corrosion staining.

B. Certification. A Type D Certification shall be submitted in accordance with Subsection 106.12.

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- C. *Fabricator's Quality Control.*** Epoxy coating will be accepted only from fabricators who have an approved quality control program. The quality control program and schedule shall be submitted to the Engineer for review and approval prior to any fabrication.

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724.00 STRUCTURAL STEEL

Description. This Section covers the requirements for structural steel, bolts, nuts and washers, shear connector studs, and filler material for welds in Section 506.

724.01 STRUCTURAL STEEL.

- A. Materials Covered.** Steel shall be furnished according to the following Specifications.
- B. General Requirements.** The general requirements for delivery of rolled steel plates, shapes, sheet piling, and bars for structural steel shall conform to AASHTO M 160.
- C. Specific Requirements.** Structural steel shall conform to the requirements of the current AASHTO Specification as follows:

Structural Steel (A 36)	M 183
High-Strength Low-Alloy Structural Steel (A 242)	M 161
High-Strength Low-Alloy Columbium-Vanadium Steels (A 572)	M 223
High-Strength Low-Alloy Structural Steel (A 588)	M 222
High-Yield-Strength, Allow Steel Plate (A 514)	M 244

Unless otherwise specified, steel used in structures shall conform to the current specification for structural steel, AASHTO M 183.

Unless otherwise shown on the Plans, structural steels for main load carrying members subject to tensile stresses listed herein shall meet the longitudinal charpy V-notch tests for zone 2 specified in the AASHTO Supplemental Requirements for the structural steel being used. Members such as shoes, diaphragms, stiffeners (including bearing stiffeners), lateral bracing, diagonals, armor joints and finger joints shall not be considered main load carrying members.

Steel for secondary non-stress-carrying members in unpainted structures shall conform to AASHTO M 222 or ASTM A 242 except that ASTM A 242 steel member shall be used only for riveted or bolted construction, unless the weldability of the steel is established in accordance with AWS D1.1. Mill test reports shall be furnished for each heat of material.

724.02 BOLTS, NUTS, WASHERS, AND OTHER FASTENERS.

- A. Bolts, Nuts and Washers.** Bolts, nuts and circular washers shall conform to the requirements of AASHTO M 164 except as provided in paragraph B of this Subsection.

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When specified on the Plans, nuts, bolts and circular washers conforming to the requirements of AASHTO M 253 shall be used. Bolts manufactured to AASHTO M 253 are identified by markings on the top of the head with the symbol "A 490" and the nuts shall be marked on one face with the legend "2H" or "DH".

B. Other Fasteners. Other fasteners which meet the chemical composition requirements of AASHTO M 164 and which meet the mechanical property requirements of the same specification in full-size tests and which have body diameter and bearing areas under the head and nut, or their equivalent, not less than those provided by a bolt and nut of the same nominal dimensions may be used. Such alternate fasteners may differ in other dimensions from those of the specified bolts and nuts.

C. Bolted Parts. The slope of surfaces of bolted parts in contact with the bolt head and nut shall not exceed 1:20 with respect to a plane normal to the bolt axis. Bolted parts shall fit solidly together when assembled and shall not be separated by gaskets or any other interposed compressible material. Holes may be punched, sub-punched and reamed, or drilled, as required by the applicable code or specification and shall be a nominal diameter not more than 1/16 inch in excess of the nominal bolt diameter.

When assembled, all joint surfaces, including those adjacent to the bolt heads, nuts or washers, shall be free of scale, except tight mill scale, and shall also be free of burrs, dirt and other foreign material that would prevent solid seating of the parts.

Contact surface within friction-type joints shall be free of oil and paint, except for inorganic zinc primer and galvanizing.

When shown on the Plans or in the Proposal that the structural steel is to be left bare and unpainted, the chemical composition of bolts, nuts and washers shall be modified to provide atmospheric corrosion resistance similar to the structural steel being used.

724.03 WELDING.

A. General. All shop and field welding shall be arc welding and shall be done in accordance with the current specifications of AWS Structural Welding Code as modified by AASHTO Standard Specifications for Welding of Structural Steel Highway Bridges, and as follows:

Radiographic and Magnetic Particle Inspection of welds when made will be paid for by the City as a part of the structural steel inspection.

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No welding will be allowed when the air temperature is lower than 20° F, when surfaces are wet or exposed to rain, snow, or wind, or when operators are exposed to inclement conditions that will hamper good workmanship.

Any moisture present at the point of welding shall be driven off by heat before welding commences. Wind breaks shall be required for the protection of all welding operations.

The welder shall place his permanent identification mark with a low-stress stencil adjacent to all welds made by him as soon as they are completed.

If a fabricating shop prequalifies its welders, welding operators and tackers in accordance with this Specification and certifies to the Engineer that the welder, welding operator or tacker has been prequalified within 12 months previous to the beginning of work on the subject structure, the Engineer may consider him qualified. The certificate shall state that the welder, welding operator or tacker has been doing satisfactory welding of the required type within the three-month period previous to the subject work. A certification shall be submitted for each welder, welding operator or tacker and for each project, stating the name of the welder, welding operator or tacker, the name and title of the person who conducted the examination, the kind of specimens, the position of welds, the results of the tests and the date of the examination. Such a certification of prequalification may also be accepted as proof that a welder, welding operator and tacker on the field welding is qualified, if the Contractor who submits it is properly staffed and equipped to conduct such an examination or if the examining and testing is done by a recognized agency which is staffed and equipped for such purpose.

B. Qualification of Welders.

1. *Field Welders.* Field welders shall be qualified in accordance with the current AWS Structural Welding Code as modified by the AASHTO Standard specifications for Welding of Structural Steel Highway Bridges.

Field welder as used herein refers to a unit consisting of the welder, the welding machine, and a class or group of manual shielded electrodes suitable for welding structural grades of steel.

The evidence of qualification of each field welder shall be submitted to and accepted by the Engineer before starting any welding operations.

2. *Shop Welders and Welding Operators.* Shop welders and welding operators shall be qualified in accordance with the Section on Qualification of the AWS Structural Welding Code, as modified by the AASHTO Standard Specifications for Welding of Structural Steel Highway Bridges.

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725.00 MISCELLANEOUS METALS

725.01 DESCRIPTION. This Section covers steel forgings, cold rolled shafting for pins and rollers, steel castings, iron castings (gray and ductile), and bronze castings.

725.02 COLD ROLLED SHAFTING FOR PINS AND ROLLERS. Pins and rollers up to 8 inches in diameter, unless marked as forgings on the Plans, may be furnished from cold finished shafting meeting the requirements of the Standard Specifications for Commercial Cold Finished Carbon Steel Bars and Shafting, AASHTO M 169, Grade 1035 or 1045, providing that tensile tests made on specimens machined from the finished shafting shall develop a minimum tensile strength of 75,000 pounds per square inch.

725.03 STEEL CASTINGS. Steel castings shall conform to the requirements of the Standard Specification for Mild to Medium Strength Carbon Steel Castings for General application, AASHTO M 103. Grade 65-35 shall be furnished unless other specified.

Castings shall be true to pattern in form and dimensions, free from pouring faults, sponginess, cracks, blow holes, and other defects in positions affecting their strength and value for the service intended. All covers and gratings, fitting into frames shall fit properly and seat uniformly and solidly.

725.04 IRON CASTINGS.

A. General. Iron Castings shall be true to pattern in form and within industry acceptable dimensional tolerances for the size and/or shape of unit. They shall be filleted at angles and the arises shall be sharp. Exposed surfaces of the castings shall be free from burnt-on sand and shall be reasonably smooth. Runners, risers, fins, and other cast-on pieces shall be removed. Where shown on the Plans, mating surfaces of cast assemblies shall be machined to provide flat, true surfaces, and ensure well-mated, non-rocking and non-rattling components.

All covers or grates fitting into frames shall fit tight and seat uniformly and solidly. They shall not rock nor rattle when installed.

Where weight is specified on the Plans, castings shall conform to such requirements. All castings shall be identified in an area as shown on the Plans or in an area visible when the unit is installed. The lettering shall be recessed 1/16 inch from the surrounding surface. In the case of a surface having a grid pattern, the lettering shall be recessed into a non-gridded area. Lettering content required shall be sufficient for identification. General requirements will be for identifying manufacturer or distributor, heat and/or pour number and date of casting.

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- B. *Gray Iron Castings.*** Gray iron castings shall meet the requirements of AASHTO M 105 and shall be Class 35 B for manhole covers and inlet grates. All others shall be Class 30 B unless otherwise shown on the Plans or specified herein.
- C. *Ductile Iron Castings.*** Ductile iron castings shall meet the requirements of ASTM A 536, Grade 65-45-12.
- D. *Malleable Iron Castings.*** Malleable iron castings shall meet the requirements of ASTM A 47.

725.05 ACCESSORIES FOR CASTINGS AND SPECIAL FABRICATED UNITS.

- A. *General.*** Bolts required for casting assemblies shall meet the requirements of AASHTO M 164. They shall be machine bolts furnished galvanized (zinc-coated), cadmium plated, or stainless steel.

Support beams required for casting assemblies shall meet the requirements of AASHTO M 183. "T" handles as shown on standard drawings for locking manhole covers shall be furnished. The minimum shall be two handles for up to and including 20 locking manhole covers and one for every 20 thereafter.

- B. *Special Fabricated Drainage Grates.*** Welded steel drainage grates shall meet the material requirements of AASHTO M 183 for the load-bearing members. Stiffeners shall be specified by the manufacturer. Welding shall meet all applicable standards as covered in Section 724 and references. Grate units shall be furnished galvanized after fabrication or painted with an inorganic zinc ethyl silicate base primer and vinyl finish coat. Galvanization shall be in accordance with the requirements of AASHTO M 111. Paint shall meet the materials requirements of Subsection 730.04. Cleaning of grate units (for either procedure) and paint application shall be as covered in Subsection 506.04 D. Painting. Only those procedures which apply to grate-sized units shall apply, and shop-applied paint shall be utilized for both coats.

Pipe for use in fabricated grates shall meet the requirements of ASTM A 53 and be furnished in standard weight, unthreaded mill finish unless otherwise stated. Hydrostatic pressure testing shall be waived. After welding, the grate units shall be thoroughly cleaned and pressure vent holes punched or drilled (only for galvanized units). See Plans for location of vent holes. See paragraph above for paint and painting requirements.

Angle iron and strap iron used for end members or spacers shall meet the requirements of AASHTO M 183 mill-finish.

Butt-welded pipe shall be acceptable for use as grate members with the approval of the Engineer.

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725.06 BRONZE. Bronze castings shall conform to the requirements of AASHTO M-107 Copper Alloy C91100. Bronze bearings and expansion plates shall conform to the requirements of the Specifications for Rolled Phosphor Bronze Bearings and Expansion Plates for Bridges and Structures, AASHTO M 108 Copper Alloy C51000.

The class of metal shall be shown on the Plans.

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726.00 DRAINAGE CONDUITS

726.01 DESCRIPTION. This section covers the materials requirements for surface and subsurface drainage conduits of the kind specified on the Plans and the requirements of Section 613.

726.02 MATERIALS.

A. *Ridged Conduits.* Materials covered in this Subsection: non-reinforced concrete pipe, drain tile, porous and perforated pipe, reinforced concrete circular, elliptical, and arch pipe; cast (ductile) iron, precast reinforced concrete box sections, manhole sections, inlet boxes, and junction boxes meeting the following requirements.

1. Concrete and Clay Culverts.

1.1 Concrete Sewer, Storm Drain, and Culver Pipe shall conform to AASHTO M 86 or M 86M (Metric).

1.2 Reinforced Concrete Culvert and Storm Drain shall conform to AASHTO M 170 or M 170M (Metric). In addition to the Pipe Classes shown in AASHTO M 170, a special design Class IV/V conforming to AASHTO M 170 may also be used. Design criteria for Class IV/V is a mid-line interpolation between the design criteria shown for Class IV (Table 4) and Class V (Table 5) of AASHTO M 170.

1.3 Reinforced Concrete Arch Culvert and Storm Drain shall conform to AASHTO M 206 or M 206M (Metric).

1.4 Reinforced Concrete Elliptical Culvert and Storm Drain shall conform to AASHTO M 207 or M 207M (Metric).

1.5 Reinforced Concrete D-Load Culvert and Storm Drain shall conform to AASHTO M 242 or M 242M (Metric).

1.6 Concrete Drain Tile shall conform to AASHTO M 178 or M 178M (Metric).

1.7 Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated shall conform to AASHTO M 65.

1.8 Clay Drain Tile shall conform to AASHTO M 179.

2. Rigid Metallic Culverts.

2.1 Ductile Iron Culvert Pipe shall conform to AASHTO M 64.

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3. *Precast Sewer Appurtenances and Box Sections for Culverts.*
 - 3.1 Precast Reinforced Concrete Manhole Sections shall conform to AASHTO M 199 or M 199M (Metric).
 - 3.2 Precast Reinforced Concrete Curb Inlet Boxes shall conform to ODOT Approved Designs.
 - 3.3 Precast Reinforced Concrete Junction Boxes shall conform to ODOT Approved Designs.
 - 3.4 Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers shall conform to AASHTO M 259 or M 259M (Metric).
 - 3.5 Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers with Less than 2 Feet of Cover Subject to Highway Loadings shall conform to AASHTO M 273 or M 273M (Metric).

4. *Concrete and Clay Underdrain.*
 - 4.1 Concrete Sewer, Storm Drain, Culvert Pipe shall conform to AASHTO M 86 or M 86M (Metric).
 - 4.2 Concrete Drain tile shall conform to AASHTO M 178 or M 178M (Metric).
 - 4.3 Perforated Concrete Pipe shall conform to AASHTO M 175 or M 175M (Metric).
 - 4.4 Porous Concrete Pipe shall conform to AASHTO M 176 or M 176M (Metric).
 - 4.5 Vitrified Clay Pipe, Extra Strength, Standard and Perforated shall conform to AASHTO M 65.
 - 4.6 Clay Drain Tile shall conform to AASHTO M 179 or M 179M (Metric).

5. *Pipe Rejection.* Rejection criteria covered herein shall apply to the previously numbered Subsections: 726.02 A. 1.1, 1.2, 1.3, 1.4, 1.5, 1.7, 3.1, 3.2, 3.3, 3.4, 3.5, 4.1, 4.3, and 4.4. A lot of pipe represented by test samples may be rejected for failure to meet any of the requirements of the governing Specifications. Any lot of pipe less than 30 days of age, which meets all requirements except the strength tests, may be retested at a later date when so requested by the manufacturer. Individual

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sections of pipe may be rejected for failure to meet the Specification requirements of manufacture, and damage acquired in handling, hauling, delivery and installation, with the following exceptions: (1) a single end crack that does not exceed the depth of the joint; (2) damaged ends when chips do not extend more than half of the joint, either from the end of the joint or along the circumference of the pipe, and providing that in the opinion of the Engineer satisfactory permanent patching can be performed during installation.

6. *Joint Filler.* Joint filler for joints in concrete pipe culverts shall meet the requirements of one of the following materials:

6.1 *Cold Applied Mastic Type.* This compound, when applied according to the manufacturer's directions, shall be resilient and adhesive and maintain an effective seal through repeated cycles of expansion and contraction. The material shall comply specifically with the following requirements:

	MINIMUM	MAXIMUM
Specific Gravity 25° C/25° C	1.290	1.350
Pounds Per Gallon	10.75	11.25
Percent Soluble in Trichlorethylene	45.0	--
Percent Ash	50.0	55.0
Percent Water by Volume	--	0
Penetration (Standard Cone) 150 gr., 5 sec., 25° C	175	200
Note: This joint filler shall not be used for precast concrete boxes.		

6.2 *Flexible Watertight Gaskets.* The joint materials shall meet the requirements of AASHTO M 198 and provide a proper fit for a satisfactory seal. A Type A Certification stating the material meets AASHTO M 198 shall be submitted.

- B. FLEXIBLE CONDUITS.** Materials covered in this Subsection: steel conduits, coated and clad steel conduits, structural plates, aluminum conduits, clad aluminum conduits, and non-metallic conduits meeting the following requirements:

1. *Steel Conduits-Culverts.*

1.1 *Metallic (Zinc or Aluminum) Coated, Corrugated Steel Culverts and Underdrains shall conform to AASHTO M 36.*

1.1.1. *Sheets for Culverts.* Zinc-coated (Galvanized) steel sheets for culverts and underdrains shall conform to AASHTO M 218. Steel sheet, aluminum-coated (Type 2) by the hot-dip process for sewer and drainage pipe shall conform to

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AASHTO M 274. Aluminum-zinc alloy coated sheet steel for corrugated steel pipe shall conform to AASHTO M 289.

1.1.2. Types of Culverts. Culverts shall be Type I (Circular) or Type II (Arch) shape unless otherwise specified on the Plans.

1.1.3. Externally Coated or Clad Culverts.

1.1.3.1. Bituminous-Coated Corrugated Metal Culvert Pipe and Pipe Arches shall conform to AASHTO M 190. Type A bituminous coating shall be used unless Type B, Type C, or Type D is specified.

1.1.3.2. Pre-coated Galvanized Steel Culverts and Underdrains shall conform to AASHTO M 245 or M 245M (Metric) or steel sheet, metallic-coated and polymer pre-coated for corrugated steel pipe conforming to AASHTO M 246 or M 246M (Metric).

1.1.3.3. When bituminous coated or mill pre-coated galvanized steel culverts are called for, aluminum coated (Type 2) steel pipe shall be an equal alternate and paid for under Subsection 613.06 F.

2. *Aluminum Conduits-Culverts.*

2.1 Corrugated Aluminum Alloy Culverts and Underdrains shall conform to AASHTO M 196. If bituminous coating is specified, it shall be by Type A Coating unless Type B or Type C Coating is specified, meeting the requirements of AASHTO M 190.

2.2 Clad Aluminum Alloy Sheets for Culverts and Underdrains shall conform to AASHTO M 197.

3. *Non-metallic Conduits-Culverts.*

3.1 Class PS 50 Polyvinyl Chloride (PVC) Pipe shall conform to AASHTO M 278.

3.2 Corrugated Polyethylene Pipe, 12 to 24-inch diameter shall conform to AASHTO M 294.

4. *Steel Conduits-Underdrain.*

4.1 Metallic (Zinc or Aluminum) Coated Corrugated Steel Culverts and Underdrain shall conform to AASHTO M 36.

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- 4.1.1. Sheets for Underdrain shall conform to AASHTO M 36 (see Subsection B. 1.1.1.)
- 4.1.2. Types. Underdrain shall be furnished in Type III pipe with Class I perforations unless otherwise specified on the Plans. Minimum thickness shall be 0.052 inch for 6-inch diameter and .064 inch for all other diameters.
- 4.1.3. Externally Coated or Clad Underdrains. When called for on the Plans, underdrain shall be furnished clad, meeting the requirements of AASHTO M 245 or M 245M (Metric). Thickness of base metal shall be as shown in 4.1.2.

5. *Aluminum Conduits-Underdrains.*

- 5.1 Corrugated Aluminum Alloy Culverts and Underdrain shall conform to AASHTO M 196. If bituminous coating is specified, it shall be Type A Coating unless Type B, Type C or Type D is specified, meeting the requirements of AASHTO M 190.
- 5.2 Clad Aluminum Alloy Sheets for Culverts and Underdrains shall conform to AASHTO M 197.
- 5.3 Types. Aluminum underdrains shall be furnished in Type III Pipe with Class I Perforations unless otherwise specified on the Plans. Thickness shall be .060 inch for all sizes.

6. *Nonmetallic Conduits-Underdrain.*

- 6.1 *Polyvinyl Chloride (PVC) Pipe.* Class PS 50 polyvinyl chloride (PVC) pipe shall conform to AASHTO M 278, or highway underdrain conforming to the requirements of ASTM F 758, Standard Specifications for Smooth-Wall Polyvinyl Chloride (PVC) Plastic Underdrain Systems for Highway, Airport and Similar Drainage with material specification of ASTM D 1784. This underdrain shall be furnished with a minimum pipe stiffness of 46 (Type PS-46).
- 6.2 Corrugated Polyethylene Drainage Tubing shall conform to AASHTO M 252. An approved, clearly identifiable mark or line shall denote the top of the underdrain pipe (for proper installation).
- 6.2 Perforations. Perforations in these pipes shall be circular or elongated slots confined to the lower half of the drainage pipe. The pipe shall be furnished round.

7. *Structural Pipe for Pipe, Pipe Arches, and Arches.*

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7.1 Corrugated Galvanized or Coated Steel.

7.1.1. Description. This subsection covers galvanized corrugated steel structural plate structures for use as culverts, drainage structures, underpasses and special shapes for field assembly of sizes and dimensions as shown on the Plans.

7.1.2 Materials. The materials shall comply with the requirements of AASHTO M 167. The minimum thickness shall be as required to accommodate the design live load on the project.

7.1.3 Fabrication. All structural plate structures shall conform to the requirements of applicable sections of AASHTO Standard Specifications for Highway Bridges. Plate sizes and shapes, forming and punching, radius of curvature, gauge, weight, tolerances, corrugation pitch and depth, and workmanship shall be as specified therein. The minimum plate thickness shall be as shown on the Plans.

7.1.4 Sampling and Testing. All sheets or plates used in the fabrication of structural plate structures will be sampled and tested as provided in AASHTO M 167.

7.2 Aluminum Alloy.

7.2.1. Description. This Subsection covers aluminum alloy structural plate structures for use as culverts, drainage structures, underpasses and special shapes for field assembly of sizes and dimensions as shown on the Plans.

7.2.2. Materials. The materials shall comply with the requirements of AASHTO M 219. The minimum plate thickness shall be as required to accommodate the design live load on the project.

7.2.3. Fabrication. All structural plate structures shall conform to the requirements of applicable sections of AASHTO Standard Specifications for Highway Bridges. Plate sizes and shapes, forming punching, radius of curvature, gauge, weight, tolerances, corrugation pitch and depth, and workmanship shall be as specified therein. The minimum plate thickness shall be as shown on the Plans.

7.2.4 Sampling and Testing. All sheets or plates used in the fabrication of structural plate structures will be sampled and tested as provided in AASHTO M 219.

7.3 Steel End Sections.

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7.3.1. *Description.* This Subsection covers metal culvert end sections for attachment to the inlet and outlet of corrugated galvanized steel pipe and corrugated galvanized steel pipe arch culverts.

7.3.2. *Materials.* The materials shall comply with the requirements of AASHTO M 36 for base metal, spelter coatings, rivets, riveting and sampling, accepted brands of metal, sheet manufacturer's certified analysis, sheet manufacturer's guarantee and thickness determination and tolerance.

7.3.3. *Fabrication.*

7.3.3.1. *Shape, Dimensions and Weights.* The units, to the shape and dimensions and number of pieces as shown in the standard drawing or special details in the Plans for steel culvert end section, shall be manufactured as integral units so they can be readily assembled and erected in place.

7.3.3.2. *Bolts.* Galvanized bolts may be used for assembly of end sections where more than one piece is used to form the skirt, when sections have not been riveted together.

7.3.3.3. *Workmanship.* It is the intent of these Specifications that in addition to compliance with the details of construction, the completed unit show carefully finished workmanship in all particulars. This requirement applies not only to the individual unit, but to the shipment as a whole.

The following defects are specified as constituting poor workmanship and the presence of any of them in an individual unit in any shipment, shall constitute sufficient cause for rejection; not meeting specified dimensions, not of the specified shape, uneven laps, ragged sheared edges, loose, unevenly lined or spaced rivets, poorly formed rivet heads, illegible brands, lack of rigidity, or dents or bends in the metal itself.

7.3.4. *Sampling and Testing.* All steel culvert end sections will be inspected for compliance with the provisions governing fabrication heretofore given. All sheet stock going into such end sections will be sampled and tested as provided in AASHTO M 36 and T 65.

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731.00 TIMBER PRESERVATIVES AND TREATMENT

Description. This Section covers the preservative and treatment of timber where preservative treatment is specified.

A. Materials. Timber preservative treatment shall conform to the requirements of AASHTO M 133. Unless otherwise provided, the type of preservative used shall be as follows:

1. *Creosote Oil and Creosote Solutions.* These preservatives shall be used for piling and structural grade timber.
2. *Creosote Oil, Creosote Solutions, Oil-Borne Preservative and Water-Borne Chromated Copper Arsenate.* These preservatives shall be used for guard rail posts, spacer blocks, guide posts, fence posts and post bracing.

B. Preparation of Treatment.

1. *General Requirements.* All lumber, timber, piling and posts shall be of the grade and size specified and shall be inspected for grade and size immediately prior to the treatment.
2. *Inspection.* All materials and processes used in the treatment shall be subject to inspection at the manufacturer's plant, which shall be equipped with all necessary gauges, appliance and facilities to enable the inspector to satisfy himself that the requirements of the Specifications are fulfilled. Inspection for conformity with the specified treatment shall be in accordance with AWPA Standard M2.

C. Handling. After treatment the lumber of timber shall be handled carefully, properly piled and allowed to dry thoroughly.

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732.00 MATERIALS FOR GUARD RAIL, GUIDE POSTS, BRIDGE RAIL, MISCELLANEOUS RAILING AND FENCES

Description. This Section covers the requirements for materials for guard rail, guide posts, bridge rail, miscellaneous railing, fences and gabion wire baskets.

732.01 METAL BEAM RAIL.

A. Beams. Corrugated steel beams shall conform to the requirements of AASHTO M 18 for the gauge specified on the Plans.

B. Guard Rail Posts and Spacer Blocks.

1. **Steel Posts.** Steel posts and spacer blocks shall be of the length and size shown on the Plans. Hot rolled (forged) steel shapes shall conform to the requirements of AASHTO M 183 and shall be furnished galvanized in accordance with AASTHO M 111. All punching, drilling, cutting, shearing and grinding shall be performed prior to galvanization. Surface defects shall be repaired by grinding, cutting, welding or other industry acceptable method, then coated with two coats of zinc-dust zinc-oxide primer meeting the requirements of Subsection 730.06. Alternate repair techniques shall be those shown in ASTM A 780, Repair of Hot-Dip Galvanized Coatings.

Steel posts and spacer blocks fabricated by the methods and requirements of ASTM A 769 are acceptable alternates. These fabricated posts shall not vary by more than 5 percent from the weight, dimensions and section properties shown for acceptable hot rolled (forged) shapes. Dimensions, weight, and section properties shall conform to the current edition of the American Institute of Steel Construction (AISC) Manual of Steel Construction, or from suppliers' technical publications endorsed by the AISC.

Sharp sheared edges on the fabricated posts and spacer blocks shall be dulled in the upper 18 inches of the post and all edges on the block. Any industry acceptable method to dull these edges may be used, such as grinding, secondary rolling, sand or shot-blasting. This operation and all hole drilling, punching, cutting, shearing, butt welding, etc., shall be fully completed prior to galvanization. Galvanization shall comply with AASHTO M 111 and repair techniques as covered above.

Tests on either type of steel post and compatible spacer blocks shall follow test procedures in the appropriate Specifications. Each cut post or spacer block is one unit of a lot which consists of 200 units, or remainder. One failure in any lot shall require testing on two other units. Failure of two of the three selected units from any lot shall be cause for rejection of the entire lot, or portion thereof.

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Testing may be done in the field for visual, mechanical or electronic checks to ensure the units adhere to the requirements of AASHTO M 183, ASTM A 769, and/or AASHTO M 111. Suppliers of hot rolled (forged) or fabricated beams shall certify their product complies with all pertinent Sections of the appropriate Specifications for production and galvanization.

Steel base plats and miscellaneous fabricated guard rail hardware shall be of the section and length as shown on the Plans. Connections to posts (cut to proper length) shall be as shown on the Plans. All cutting, welding, and drilling required shall be completed prior to galvanization. Steel plate shall conform to the requirements of AASHTO M 183 and the galvanization shall conform to requirements of AASHTO M 111.

2. *Wood Posts.* Wood posts and spacer blocks shall be of the length and size specified on the Plans. Both type posts (sawed and round) and sawed spacer blocks shall be cut from live trees and shall be close grained. Posts and blocks shall contain only sound wood.

- 2.1 *Round Posts.* Both the outer and inner bark shall be completely removed from all round posts by any process which will yield a relatively smooth surface without excessive damage to the grain and/or fiber of the post. All knots shall be trimmed flush with the face. Defects of any kind which give any post or block an unsightly appearance or impair its strength or durability shall be cause for rejection of the individual unit. Surface and strength defects could include distressed outer fiber and/or grain, loose or unsound knots, excessive size or number of shrinkage cracks, and improperly cleaned outer surface for preservative treatment.

Sound knots will be permitted provided they occur as single distinct knots (not clustered) and the largest dimension of the knot does not exceed 1/3 the diameter (1/9 the circumference) at the point where the knot occurs. Knots are not permitted in the slabbed portion (upper 18 inches of the post). Posts shall not contain short or reverse bends and shall be straight. A line from the butt center to the top center shall not deviate more than 1-1/2 inch from the centerline of the post.

- 2.2 *Sawed Posts and Spacer Blocks.* Sawed posts and spacer blocks shall be of the size and length shown on the Plans. They shall meet the requirements of Section 727 for timber and lumber, furnished rough. Minimum stress grade shall be 1200 F unless otherwise shown on the Plans.

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- 2.3 *Post Weakening.* The leading posts in the approach anchor unit shall be weakened by drilling holes at the ground line as shown on the Plans.

An alternate method of weakening the leading posts in the approach anchor unit will be to make a saw cut (with chainsaw, etc.) 1/2 inch deep across the eight inch sides of the rectangular posts or 1/4 inch deep around the perimeter of round posts. These cuts shall be just above the ground line.

- 2.4 *Preservative Treatment and Inspection.* Wood posts and spacer blocks shall be preservative treated in accordance with Section 731.

The size of the post or block shall be determined at the preservative treatment plant immediately prior to treatment. The diameter of round posts shall be determined by a circumference-diameter tape. Minimum diameter at the bottom edge of the slabbed face shall not exceed 3/4 inch less than the nominal diameter, and the actual diameter at any point shall not vary from the nominal diameter by more than one inch, over or under.

All sawing, chamfering, boring, slabbing or cutting shall be performed prior to preservation treatment. The only exceptions are the holes shown drilled at the ground line for weakening the leading posts in the approach anchor unit, or holes enlarged or drilled into new wood to facilitate guard rail attachment. These holes shall be thoroughly and uniformly treated by pulling or pushing a preservative solution saturated rag through or into the holes. Multiple passes of the saturated rag may be required to obtain the treatment level required.

- C. *Guard Rail Hardware.*** Unless otherwise specified, all fittings, bolts, washers and other accessories shall be galvanized in accordance with the requirements of AASHTO M 111 or M 232, whichever may apply.

732.02 GUIDE POSTS. Guide posts and underdrain marker posts shall be round posts unless otherwise shown on the Plans. They shall be furnished unslabbed and undrilled and meet the requirements of Subsection 732.01 B. 2.

732.03 METAL BRIDGE RAILING.

A. *Materials.*

1. *Structural Steel Shapes for Posts and Rails.* Structural steel shapes for posts and rail shall meet the requirements of Section 724.

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2. *Metal Beams.* Metal beams shall meet the requirements of Subsection 732.01.
3. *Aluminum Alloy Tubes.* Aluminum alloy tubes for bridge railing shall meet ASTM B 221, alloy 6063 or 6061 T6.

Welding, when shown on the Plans or permitted, shall be in accordance with Subsection 720.03 A. 1.

A certificate of analysis executed by the producer shall be furnished to the Department, setting forth the chemical analysis and test results for tubes.

4. *Cast Aluminum Alloy Bridge Railing Posts.* Cast aluminum alloy bridge railing posts shall meet the requirements of AASHTO M 193.

Welding, when shown on the Plans or permitted, shall be in accordance with Subsection 720.03 A. 1.

- 4.1 *Anchor Bolts.* Anchor bolts and anchoring methods for cast aluminum alloy bridge railing posts shall be as shown on the Plans.

732.04 PIPE RAILING.

- A. *Galvanized Steel Pipe and Fittings.*** Galvanized steel pipe and fittings shall meet the requirements of ASTM A 53, standard weight pipe. The requirement for hydrostatic testing shall be waived.
- B. *Black Steel Pipe and Fittings.*** Black steel pipe and fittings shall comply with the requirements of ASTM A 53, standard weight pipe. The requirement for hydrostatic testing shall be waived.

732.05 WIRE CABLE AND FITTINGS. Materials shall meet the requirements of AASHTO M 30.

732.06 FENCE, STYLE WWF OR FENCE, STYLE SWF.

- A. *Description.*** This item covers the materials requirements for fabric, strand wire and other wire items, framework for fence and gates, and all fastening and bracing hardware necessary for the construction of woven wire or strand wire fence. The height of fence, or number of strands, the height and size of opening for gates, and the shape, size, and length of posts shall be as shown on the Plans or in the Proposal.

B. *Materials.*

1. *Wire Items.*

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- 1.1 *Woven Wire.* The woven wire shall be design number 832-6-12-1/2 with a Class 1 zinc coating meeting the requirements of AASHTO M 279 or wire of design number 832-6-12-1/2 with a Class 1 aluminum coating meeting the requirements of ASTM A 584.
- 1.2 *Barbed Wire.* Zinc-coated steel (galvanized) barbed wire shall consist of two strands of 12-1/2 gage (0.099 inch dia.) steel wire twisted in the same direction, or in alternate directions, with 14 gage (0.080 inch dia.) full or half-round 4-point barbs spaced 5 inches apart, with a Class 1 zinc coating on the 12-1/2 gage (0.099 inch dia.) wire. Also acceptable is wire consisting of two strands of 15-1/2 gage (0.067 inch dia.) steel wire twisted in alternate directions, with 16-1/2 gage (0.058 inch dia.) full round 4-point barbs spaced 5 inches apart. The coating shall be a Class 3 zinc-coating on the 15-1/2 gage (0.067 inch dia.) wire. The wire described here shall meet all requirements of AASHTO M 280. Aluminum-coated steel barbed wire shall consist of two strands of 12-1/2 gage (0.099 inch dia.) steel wire twisted in the same or in alternate directions, with 14-gage (0.080 inch dia.) full or half-round 4-point barbs spaced 5 inches apart. The wire may be furnished with aluminum coated steel wire bars, or with aluminum alloy bars. The strands (main wires) shall be aluminum-coated steel-barbed wire meeting the requirements of ASTM A 585. Any barbed wire furnished shall have a minimum assembly break strength of 950 pounds.
- 1.3 *Smooth Wire.* Smooth zinc-coated (galvanized) carbon steel wire of 11-gage (0.120 inch dia.) medium or hard temper, minimum 85,000 pounds per square inch tensile strength with a Class 1 Coating, or 9 gage (0.148 inch dia.) soft-temper, minimum 60,000 pounds per square inch tensile strength with a Class 1 Coating may be substituted for the top wire or any or all barbed wire shown on the Plans or in the Proposal, with the approval of the Engineer. The smooth wire shall meet the requirements of ASTM A 641.
- 1.4 *Barbless Wire.* Zinc-coated steel (galvanized) barbless wire shall consist of two strands of 12-1/2 gage (0.099 inch dia.) steel wire twisted in the same direction, or in alternate directions, with a Class 1 zinc coating. Also acceptable is wire consisting of two strands of 15-1/2 gage (0.067 inch dia.) steel wire twisted in alternate directions with a Class 3 zinc coating. The wire described here shall meet all requirements of AASHTO M 280. Aluminum-coated steel barbless wire shall consist of two strands or 12-1/2 gage (0.099 inch dia.) steel wire twisted in the same or alternate direction. The wires shall have a minimum Class 1 aluminum coating. Aluminum-coated steel barbless wire shall meet the requirements of ASTM A 585. All barbless wire furnished shall have a minimum assembly break strength of 950 pounds.

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- 1.5 *Tension Wire.* Diagonal steel tension wire may be either size listed in Subsection 732.06 B. 1.3.
- 1.6 *Fan, Corner, End, Stretchers and Gate Posts.* These posts shall be treated wood of the length and nominal diameter as shown on the Plans. They shall be sound and reasonably straight and shall be treated in accordance with Section 731 of the Specifications. The minimum wood post quality standard grades are shown in ASTM F 537, Section 6.3.
- 1.7 *Line Posts.* Line posts shall be either preservative-treated wood or steel, of the nominal diameter (wood), or acceptable shape and weight (steel), and specified length shown on the Plans or in the Proposal. The kind of material selected shall be used throughout any one project except in cases where the Engineer approves a mixture of materials in writing. Wood line posts shall meet the post quality standards of ASTM F 537, Section 6.3 and shall be preservative-treated as covered in Section 731 of the Specifications. Steel posts shall meet the requirements of AASHTO M 281. They shall be furnished galvanized or painted and have an adequate number of deformable clip protrusions on the post, or be furnished with the same number of wire ties as the number of strands to be joined to the posts.
- 1.8 *Post Ties (Wire Ties).* Post ties shall meet the requirements of AASHTO M 281 and shall be furnished with a Class 1 zinc coating in minimum 11-gage (0.120 inch dia.).
- 1.9 *Gates.* Gates may be furnished with a pipe or tubular framework covered with the same type strand or woven wire as the fence. Pipe or tubing for the gate frames shall meet the requirements of ASTM A 53, standard weight steel pipe (Schedule 40) but the pressure testing (hydrostatic) requirement will be waived. The minimum size will be 1.66 inches outside diameter pipe with a wall thickness of 0.140 inch. The frame shall be covered and braced as indicated on the Plans. Fittings, latches, and hinges shall be a type approved by the Engineer. Pipe or tubing may be substituted for the pipe specified above. The substitution formulation will be as shown on the Plans or in Subsection 732.07 C. 2.2.

Commercially available ranch type metal panel gates may be furnished as an alternate unless otherwise shown on the Plans. Acceptance will be based on visual inspection by the Engineer. Aluminum-coated steel, aluminum alloy or galvanized steel, mill finish or painted, are all acceptable materials for this item.

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1.10 *Hardware.* Various hardware items, hinges and gate latches shall be furnished as shown on the Plans or as recommended by the gate manufacturer. They shall be furnished galvanized in accordance with ASTM A 90 and AASHTO M 232, or with a protective coating compatible with the gate coating or alloy. Eye bolts for fastening fence to existing headwalls or wingwalls on culverts shall be furnished galvanized.

1.11 *Staples.* Staples used for fastening wire to wood shall be made of 9-gage (0.148 inch dia.) galvanized wire. They shall be minimum 1.5 inches long.

1.12 *Nails.* Nails shall be round or oval steel wire. They shall be 40 pwt. nails or 20 pwt. spikes, and furnished galvanized.

732.07 FENCE-STYLE CLF.

A. *Description.* This item covers the materials requirements for chain link fabric and other wire items, framework for the fence and gates, and all fastening and bracing hardware necessary for the construction of chain-link type fence. The height of the fence fabric, the width and height of the gate openings, the size, shape and length of posts and the size and shape of framework members shall be as shown on the Plans or in the Proposal.

B. *Classifications.* The following classifications and combinations of acceptable materials will be used throughout this Specification:

1. Fence, Style CLF, Type I shall consist of zinc-coated (galvanized) steel wire fabric on either a steel or aluminum mounting system.
2. Fence, Style CLF, Type II shall consist of aluminum-coated steel wire fabric on either a steel or aluminum mounting system.
3. Fence, Style CLF, Type III shall consist of aluminum-alloy fabric on either steel or aluminum mounting system.
4. Fence, Style CLF, Type IV shall consist of vinyl-coated or PVC plastic coated galvanized steel wire fabric on either zinc-coated steel or aluminum mounting system of the same color or a harmonizing color.
5. Fence, Style CLF, Type XX, NOBAR. This nomenclature indicates any of the four combinations of acceptable materials and NOBAR indicates no barbed wire climb barriers above the fence fabric.

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6. Fence, Style CLF, Type XX, BARR. This nomenclature indicates any of the four combinations of acceptable materials and BARR indicates fence fabric topped by the number of strands of barbed wire climb barrier as shown on the Plans.
7. Nomenclature. The full nomenclature as shown in Subsection 732.07 B. 5. and 6. is for ordering information only. Unless otherwise specified on the Plans, the Type is optional with the Contractor. The fence pay item may not contain the full nomenclature.

C. Materials.

1. *Wire Items.*

1.1 *Fabric.* Unless otherwise specified, the fabric shall be 9-gage (0.148 inch dia.) wire woven in two inch mesh. Unless otherwise specified herein, or on the Plans and in the Proposal, all fabric shall meet the minimum requirements of AASHTO M 181 and references for the type fabric used.

1.2 *Tension Wire.* The tension wire shall meet the requirements of AASHTO M 181, Class 1 with a minimum zinc coating weight of 0.80 oz/sq ft.

1.3 *Barbed Wire.* Barbed wire shall meet the requirements of Subsection 732.06 B. 1.2.

1.4 *Post Ties.* Post ties shall comply with Subsection 732.07 C. 3.4.

1.5 *Wire Ties.* Wire ties shall comply with Subsection 732.07 C. 3.4.

2. *Framework Items.*

2.1 End (Terminal), Stretcher (Pull), Corner, and Gate Posts shall be the size, shape, and length as shown on the Plans or in the Proposal. Fan posts shall be the same type of post, shape and size and of a length necessary to provide a smooth top line on the fence. Pipe for round posts shall be Grade 1 steel posts or Grade 2 steel posts meeting the requirements of AASHTO M 181. Grade 1 steel posts shall be pipe meeting the requirements of ASTM A 53 with a minimum 1.8 oz./sq. ft. zinc coating. The post shall have the dimensions shown on the Plans for the height of fence specified. The hydrostatic tests will be waived on the pipe used for fence posts, and the pipe shall be furnished with plain ends.

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Roll-formed shapes (other than round) shall be furnished in the size, shape and length shown on the Plans. Unless otherwise specified, they shall be furnished with a minimum 1.8 oz. sq. ft. zinc coating and be fabricated from steel sheet meeting the requirements of ASTM A 570, Grade 45. See Subsection 732.07 C. 2.2 for round roll-formed post shapes, materials and substitution formula.

- 2.2 Line Posts. Line posts shall be the size, shape and length as shown on the Plans or in the Proposal for the height of fence as specified, and as shown in Subsection 732.07 C. 2.1.

Grade 2 steel posts shall be round pipe or tubing manufactured by cold rolling and electric resistance welding of steel strip. Exterior and interior corrosion resistance coating shall conform to the requirements of AASHTO M 181. This applies to material used in Subsections 732.07 C. 2.3 and 732.07 C. 2.4.

Properties (dimensions, weight, and section modulus) for the round pipe as shown in the scheduled on the standard drawing are for Schedule 40 pipe, meeting the requirements of ASTM A 120, (galvanized) zinc-coated. Pipe meeting the requirements for Grade 2 pipe of AASHTO M 181 are acceptable substitutes. The pipe (or tubing) shall be tested to determine the tensile and yield strengths, and the following criteria shall be met. The product of the section modulus (from the scheduled on the standard drawing) multiplied by 25,800 (minimum yield strength in pounds per square inch for Schedule 40 pipe) shall be equal to or be exceeded by the product of the section modulus of the Grade 2 pipe multiplied by its tested yield strength in pounds per square inch. Steel used in Grade 2 pipe shall have a minimum 50,000 pounds per square inch yield strength. The outside diameters of the substituted pipes shall be within 0.1 inch of the Schedule 40 pipe and the section modulus of the Grade 2 (cold-formed process) pipe shall be determined by the formula:

$$SM = \pi (OD^4 - ID^4) / 32 \times OD$$

Where: SM = Section Modulus
OD = Outside Diameter
ID = Inside diameter
 $\pi = 3.1416$ (a constant)

Thickness measurement of the pipe shall be made with micrometers accurate to 0.001 inch.

- 2.3 Rail (Braces and Top Rail). Material for top rail and braces shall meet the requirements of ASTM A 501 or ASTM A 53 and be furnished in the size and shape as shown on the Plans or in the Proposal. They shall be furnished galvanized to comply with ASTM A

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53. See Subsection 732.07 C. 2.2 for round roll-formed brace and rail materials and substitution formula. Dimensions, weight and section properties shown on the Plans are those of ASTM A 501. When substituting for ASTM A 53 pipe, use the same outer diameter pipe. Hydrostatic testing on ASTM A 53 pipe shall be waived.

2.4 Gate Frame. Material for gate frames shall be the size and shape as shown on the Plans or in the Proposal. They shall meet the requirements of ASTM A 501 or ASTM A 53 and be furnished galvanized to the requirements of ASTM A 120. See Subsection 732.07 C. 2.2 for round roll-formed framework materials and substitution formula. Dimensions and section properties shown on the Plans are those of ASTM A 501. When substituting for ASTM A 53 pipe, use the same outer diameter pipe. Hydrostatic testing on ASTM A 53 pipe shall be waived.

3. *Fence Fittings.* The materials requirements, coating specifications and inspection procedures of the following items necessary for chain link fence erection is covered in ASTM F 626, as amended herein:

3.1 Post and line post caps.

3.2 Rail and brace ends.

3.3 Sleeves for top rail.

3.4 Tie wire and clips, minimum 12-gage (0.106 inch dia.) with 0.8 oz./sq. ft. zinc coating, or aluminum wire as shown.

3.5 Tension and brace bands.

3.6 Tension bars.

3.7 Truss rods.

3.8 Barb arms.

732.08 GABION WIRE BASKETS. Gabion baskets shall be constructed of wire mesh. The wire mesh shall be made of heavily galvanized steel wire having a minimum size of 0.120 inch diameter (U.S. Wire Gage No. 11). The selvage wire shall be made of heavily galvanized steel wire having a minimum size of 0.148 inch diameter (U.S. Wire Gage No. 9). The tie and cross connection wire shall be made of heavily galvanized steel wire having a minimum size of 0.092 inch diameter (U.S. Wire Gage No. 13). All mesh, selvage tie and cross-connection wire shall equal or exceed Federal Specification QQ-W-461H for wire, steel, carbon, (round, bare and coated) including the following specific requirements: finish 5 and class 3 weight of zinc coating.

Gabion basket dimensions shall be subject to a tolerance limit of +3 percent of manufacturer's stated sizes.

The wire mesh shall be twisted to form openings of uniform size generally hexagonal in shape. The maximum linear dimension of the mesh opening shall not exceed 4-1/2 inches, and the area of the mesh opening shall not exceed 8 square

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inches. The mesh shall be fabricated in such a manner as to be non-raveling. Non-raveling is defined as the ability to resist pulling apart at any of the twists or connections forming the mesh when a single strand in a section of mesh is cut.

Gabion baskets shall be fabricated in such a manner that the sides, ends, lid and diaphragms can be assembled at the construction site into rectangular baskets of the specified sizes. Gabion baskets shall be of single unit construction; the base, lid, ends, and sides shall be either woven into a single unit or one edge of these members connected to the base section of the gabion in such a manner that strength and flexibility at the point of connection is at least equal to that of the mesh.

The gabion baskets shall be equally divided by diaphragms, of the same mesh and gauge as the edges of the gabion, into cells the length of which does not exceed the base width. The diaphragms shall be secured in proper position on the base in such a manner that no additional tying at this junction will be necessary.

All perimeter edges of the mesh forming the gabion shall be securely selvaged or bound so that the joints formed by tying the selvages have at least the same strength as the body of the mesh.

Tie and connection wire shall be supplied in a sufficient quantity to securely fasten all edges of the gabion baskets and diaphragms, and to provide four cross-connecting wires in each cell whose height is $\frac{1}{3}$ or $\frac{1}{2}$ the base width of the gabion if the gabion is placed on its base or eight connecting wires in each cell if it is placed so that the side height becomes the base, and eight connecting wires in each cell whose height equals the base width of the gabion. Double the ordinary number of internal and external tie wires shall be used in gabions which are a part of the bridge abutments, including wingwalls, or in gabions which are designated on the Plans to require double tie wires.

The Contractor shall furnish a Type A Certification for the wire in accordance with Subsection 106.12 of the Standard Specifications.

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733.00 MISCELLANEOUS MATERIALS

General. All materials for pipe, fittings, valves, valve boxes, hydrant risers, and other miscellaneous materials covered shall comply with the requirements of the individual materials set out in this Section.

733.05 REFLECTIVE SHEETING FOR GUIDE POSTS. This item covers reflective sheeting to be used in reflectorized guide posts, or any other post or barrier which requires reflectivity, and shall be in accordance with the requirements for reflective sheeting as provided in Subsection 719.04., Type A. Reflective sheeting for use on the underdrain outlet post (guide post) shall meet the same requirements. Metal backing plates (sheet) for these posts shall conform to the requirements of ASTM A 526, in minimum 30-gage (0.0157 inch thickness) for galvanized sheet, or ASTM B 209 Alloy 1060-H12 in minimum 0.016 inch thickness. Metal bands shall be prepared to receive the reflective sheeting by degreasing and fully cleaning or caustic etching. Wording on band shall be as shown on the current Standard Drawing.

733.07 NONSTICK GROUT.

A. General. Non-shrink grout shall consist of a mixture of portland cement, fine aggregate, water and an approved non-shrink admixture.

B. Materials.

1. *Portland Cement, Water and Aggregate.* Portland cement, mixing water, and aggregate shall conform to Section 701. The gradation requirements of the aggregate will conform to the following:

SIEVE SIZE	PERCENT PASSING
No. 16	100
No. 50	20-50
No. 200	0-10

2. *Non-shrink Admixture.* Non-shrink admixture shall be the type manufactured under a trade name for use in non-shrink grout and approved by the Materials Engineer prior to use.
3. *Premix.* Manufacturer's premix formulations may be used when approved by the Materials Engineer prior to use.

C. Non-shrink Mortar.

1. *Proportioning.* Unless otherwise specified by the manufacturer of the non-shrink admixture, the dry materials shall be proportioned on a 1:1:1 basis by weight, or as follows:

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1 sack portland Cement
100 pounds sand
200 pounds non-shrink admixture

2. *Mixing.* The proportioned materials shall be combined and mixed until thoroughly blended. If the sand is noticeably wet, the quantity of free moisture shall be determined as a percentage of the dry weight and the weight of sand adjusted accordingly. Water shall be added in increments until the desired consistency has been obtained. The mixing water will be estimated as a percentage of the total weight of the dry materials. Mortar not used within 20 minutes after completion of mixing shall be discarded. Re-tempering the mortar will not be permitted.

733.08 WATERSTOPS.

- A. General.** This item covers the requirements for plastic waterstops and rubber waterstops to be used in construction joints of structural concrete, when shown on the Plans, in reasonably close conformity with the dimensions and location shown on the Plans or established by the Engineer.

Waterstops shall have a dense, homogeneous cross-section and shall be produced in continuous lengths not to exceed 100 feet. If any field splices are necessary, they shall be made in accordance with the manufacturer's instructions.

- B. Materials.** When a particular type of material is not shown on the Plans, either type of material will be acceptable.

Subject to visual inspection and approval by the Engineer, material from an approved source will be accepted on the basis of the manufacturer's identification markings showing the appropriate grade of material.

1. *Plastic Waterstops.* The waterstops shall be extruded from an elastomeric plastic compound, the resin of which shall be a polyvinyl chloride (PVC). The compound shall contain any additional resins, plasticizers, stabilizers, or other materials needed to insure that when the material is compounded, it will meet the performance requirements given in this Specification.

Sampling shall be in accordance with ASTM Designation D 15 Methods of Sample Preparation for Physical Testing of Rubber Products and Federal Test Method standard No. 601 Rubber, Sampling and Testing.

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The material shall meet the following requirements:

PROPERTY	TEST METHOD	PHYSICAL REQUIREMENT
Tensile Strength (die III) min.	4111 a/	1750 psi
Ult. Elongation (die III) min.	4121 a/	350 percent
Low Temp. Brittleness, no failure such as cracking or chipping at	ASTM D 746	-35° F
Stiffness in flexure, ½ in. Span, min.	ASTM D 747	400 psi
a/ Federal Test Method Standard No. 601.		

2. *Rubber Waterstops.* The material for rubber waterstops may be a natural rubber, suitable synthetic rubber, or a blend of natural and suitable synthetic rubber.

Sampling shall be in accordance with ASTM Designation D 125 Methods of Sample Preparations for Physical Testing of Rubber Products and Federal Test Method Standard No. 601 Rubber; Sampling and Testing.

The material shall meet the following requirements:

PROPERTY	TEST METHOD a/	PHYSICAL REQUIREMENTS
Tensile Strength (die III) min.	4111	2500 psi
Hardness, Shore Diameter, Type A	3021	60-70
Ult. Elong. (die III) Min.	4121	450%
300% Modulus, min.	4131	900 psi
Water Absorp., 7-day immersion, 73.4° 2° F, by wt. max.	6631	5%
Compression Set, max.	3311 or ASTM D 395, Method B	30%
Tensile Strength after aging Oxygen bomb method, min.	7111	80%
a/ Federal Test Method Standard No. 601.		

- C. Acceptance.** A Type D Certification in accordance with Subsection 106.12 shall be required.

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735.00 MATERIAL FOR ROADSIDE DEVELOPMENT AND EROSION CONTROL

735.01 DESCRIPTION. These Specifications establish the material requirements for roadside development and erosion control.

735.02 SODDING AND SPRIGGING MATERIALS.

A. General. Bermuda grass sod or sprigs to be used as source material shall be a thick stand of common bermuda grass growing on fertile topsoil. Types of bermuda grass other than Common may not be used unless specified or approved by the Engineer. The vegetative parts (rhizomes, stolons, and roots) of bermuda grass shall be viable as indicated by a dense, deep-rooted stand.

The source for sod and sprigs shall be free of reproducing parts of weeds classified as Prohibited Noxious and shall be as free of other legally Restricted Noxious plant materials as required by the Oklahoma Department of Agriculture Seed Law. The proposed source of sod or sprigs will be approved by the Engineer before the beginning of sodding or sprigging operations. Prior to approval, the area shall not be tilled or mowed. However, all vegetative growth exceeding 3 inches in height shall be mowed and the residue removed prior to harvesting the sod or springs.

The sod or sprigs shall be moist when excavated from the source and shall be kept moist until planted. Watering of the sod source, if to be measured for payment, shall be performed when and as directed by the Engineer. Sod in storage which becomes dry, shall not be remoistened and used, but shall be discarded.

B. Sodding. This material shall consist of vegetative parts (rhizomes, stolons, and roots) of bermuda grass with an appreciable quantity of adhering soil.

1. Solid Slab Sod shall be rectangular slabs of bermuda grass having minimum dimensions designated on the standard detail. Bermuda grass vegetative parts shall exist throughout the slab and shall be obtained from soils with a minimum P. I. of 3 and with a soil depth of ¾" to 1" thickness. The slab must have a dense vegetative growth and be capable of being transported in a condition closely resembling its original state.
2. Mulch Sod shall consist of fertile topsoil that contains bermuda grass vegetative parts which have not been harvested within the previous 12 months. Before excavation, the sod shall be disked in different directions to the depth of planned excavation. Each disking shall be at right angles to the preceding disking until the Bermuda grass vegetative parts have been cut into small pieces. The depth of excavation shall be limited to 6 inches unless otherwise determined by the Engineer. The sod shall be excavated immediately after being disked. The sod may be windrowed or otherwise stored for short periods and shall be kept in a moist condition in a manner approved by the Engineer.

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3. Mulch Sprigging shall conform to the Specifications for mulch sod, except the depth of excavation shall not exceed 4 inches.

C. *Sprigging.* This material shall consist of vegetative parts (rhizomes, stolons, and roots) of the Bermuda grass which has been separated from a majority of the adhering soil.

The sprigs for row sprigging and broadcast sprigging shall be removed from the soil with an approved automatic sprig harvester which digs, cleans, and loads the sprigs in one continuous operation. The vehicle in which the sprigs are loaded for transportation shall not have open sides.

As soon as the vehicle is loaded, the sprigs shall be wet thoroughly with water and covered with a heavy canvas or other approved cover to reduce moisture loss. They shall be kept moist and covered until planted, and shall be planted within 48 hours after removal from the soil.

735.03 PLANTING MATERIALS.

A. *Plant Materials.* The grading tolerances, quality definitions, balling and burlapping Specifications, container and bare-root requirements of plant materials, shall meet the requirement of ANSI Specification Z-60.1, Nursery Stock, except as modified by these Specifications, the Plans or in the Proposal.

All plant materials shall be nursery-grown stock unless collected plant materials are specified or permitted by the Engineer.

Plant material shall be well-grown, health, representative samples of their normal species or variety with a vigorous and well-developed root system. Trees shall have reasonable straight stems and shall be well-branched and symmetrical in accordance with their natural habits of growth. The branch system shall be free from disfiguring knots, sun scald injuries, abrasions of the bark, dead or dry wood, broken terminal growth or other objectionable disfigurements.

Nursery-grown stock are those plants which have been grown by proper cultural treatment and have been transplanted or root-pruned two or more times according to approved nursery practices. All evergreens shall be either balled and burlapped (B & B) or containerized (canned). Deciduous plants are to be bare-rooted (BR), (B & B), or (canned) as specified by the Engineer. (B & B) plant materials shall have solid, firm balls, which have been dug from firm soil that contains a minimum amount of sand.

When nursery grown plants of the species, size and grade specified are not available, collected plant material meeting the Specifications may be substituted if approved in writing by the Engineer. Collected plant material

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shall be dug by an approved nursery doing the collecting. The Contractor shall notify the Engineer in writing at least 2 weeks in advance of the time and place of digging collected plant materials so that an inspection of the work and material can be made. Any additional cost for materials, equipment, labor and incidentals required to acquire and use the substitute collected material shall be at the Contractor's expense.

The spread of roots and minimum ball size for collected plant material shall be at least 1/3 greater than that for nursery-grown plant material as specified in ANSI Specification Z-60.1.

Plant materials shall be packed to insure adequate protection against climatic, seasonal or other injuries during transit. Bare rooted (BR) plants shall have their roots kept in a moist, healthy condition, with a suitable material.

Plant materials may be inspected for provisional approval, at any time during the life of the contract. Plant materials not meeting Specifications shall be rejected, and if on the project, removed immediately and replaced at the Contractor's expense.

At the time of delivery all plant materials shall be accurately and legibly tagged with their names and sizes. The Contractor shall furnish the Engineer a written statement, giving the origin of each shipment; an invoice showing quantities, sizes and varieties, and inspection certificates, as required by Federal and State laws, certifying the plant materials to be free from plant diseases and insect pests.

B. *Planting Soil Mix.* The planting soil mix shall contain one part sand*, three parts sandy loam*, and one part peat moss by volume. These materials shall meet the following requirements:

Sand. Sand is defined as soil material that contains 85 percent or more of sand. The percentage of silt, plus 1-1/2 times the percentage of clay, shall not exceed 15 percent. Included are coarse sand, fine sand, and very fine sand.

Sandy Loam. Sandy loam shall meet one of the following definitions:

1. Soil material that contains 20 percent clay or less, and the percentage of silt plus twice the percentage of clay exceeds 30 and contains 52 percent or more sand.
2. Soil material that contains less than 7 percent clay, less than 50 percent silt, and between 43 and 50 percent sand.

Peat Moss. Peat moss shall consist of at least 75 percent of partially decomposed stems and leaves of sphagnum, hypnum, polytrichum and other mosses in which the fibrous and cellular structure is still recognizable. It shall

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be brown to black in color. Humus peat shall not be acceptable. Peat moss shall have the following characteristics:

- Moisture content shall not exceed 60 percent by weight.
- Ash content shall not exceed 20 percent, based on the oven dry weight of the material.
- The pH value shall be between 3.2 and 7.0 at 77° F.
- Water holding capacity shall be not less than 400 percent, by weight, on an oven dry basis.

The Contractor shall furnish the Engineer with a certificate stating the type of peat moss, the brand name and the place of origin. The certificate shall also contain the cubic feet of compressed material, the compression ratio and the approximate weight per cubic foot. A certificate will not be required if this information is marked on the bales.

(*Textures as determined by U. S. Department of Agriculture Soil Classifications. The materials shall be well-blended until homogenous in texture and composition.)

The planting soil mix shall be free from subsoil roots, brush, refuse and other offensive or deleterious materials that would interfere with proper planting procedures or with future maintenance. It shall be free from harmful quantities of toxic salts or other material that might retard establishment or interfere with the future growth of the specified plant. The mix shall be free from the seeds, roots and other reproducing parts of weeds classified as "Prohibited Noxious" and shall be free of other legally "Restricted Noxious" plant materials as required by Oklahoma Department of Agriculture regulations.

The planting soil materials shall be stockpiled and mixed at a predetermined location approved by the Engineer.

- C. Vegetable Compost.** The material shall consist of cotton seed hulls, peat moss, chopped peanut hulls, partially decayed and chopped cotton burrs or any combination of these, and shall be free from seeds or other reproducing parts of noxious or objectionable weeds.
- D. Orange Shellac.** An approved commercial material, manufactured especially for use on pruning cuts.
- E. Tree Wrap.** The wrap shall be an approved commercial wrapping material made from 2 sheets of 30-pound crepe draft paper that are held together with a suitable asphalt adhesive.

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735.04 SEEDING MATERIALS. The kind and quantity of seeds to be planted per acre will be indicated on the Plans or in the Proposal. A list of seeds and the Specifications for them are given in table of seed specifications.

The seed shall be furnished in sealed bags, with each "lot" in separate bags even though mixtures may be called for on the Plans. All labeling required by law shall be intact and legible.

The Contractor shall furnish the Engineer 2 copies of the invoices for the seed. The invoice shall described each species by name, variety, if any, and treatment (hulled, scarified, etc.), if any.

Each "lot" of seed furnished shall have been officially sampled and tested by the Oklahoma State Board of Agriculture, and 2 copies of the report shall be supplied to the Engineer by the Contractor. Each seed test shall have been completed not more than 9 months prior to delivery of the seed.

The information furnished in the seed report for a particular "lot number" shall agree with information appearing on the seed tags having the same "lot number", or the seed of that "lot" will be rejected.

The seed and tags shall not be removed from the original tagged and sealed bag until approved by the Engineer. After approval, the seed may be mixed, sacked and batched as required to facilitate planting, but shall be tagged for identification and weight. The mixing or sacking into batches shall be performed under supervision of the Engineer.

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TABLE OF SEED SPECIFICATIONS				
Kind of Seed Common and Botanical Name	P.L.S. Index Minimum (Note 1.)	Purity: Minimum (percent)	Germination: Minimum (percent)	Weed Seeds: Maximum Permitted (percent) (Note 4.)
Bermuda grass, common (Cynodon dactylon) unhulled	80			0.2
Bermuda grass, common (Cynodon dactylon) hulled	82			0.2
Bermuda grass, Guymon variety (Cynodon dactylon) unhulled	80			2.0
Bermuda grass, Guymon variety (Cynodon dactylon) hulled	82			2.0
Bluestem, big (Andropogon gerardi) (Note 2)	20			
Bluestem, Caucasian (Andropogon caucasicus)	15			
Bluestem, little (Andropogon scoparius) (Note 2)	15			
Bluestem, Plains (Bothrichloa ischaemum)	30			1.0
Bluestem, sand (Andropogon halli) (Note 3)	20			
Bluestem, yellow (Andropogon ischaemum)	18			
Brome, smooth (Bromus inermis)	70			2.0
Buffalograss (Buchloe dactyloides) (Note 2 & 3)	55			
Burclover (Medicago hispida, arabic or rigidula)		98	85	1.0
Clover, large hop				

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(Trifolium procumbens) (Note 5)		95	85	0.5
TABLE OF SEED SPECIFICATIONS (CONTINUED)				
Kind of Seed Common and Botanical Name	P.L.S. Index Minimum (Note 1.)	Purity Minimum (percent)	Germination Minimum (percent)	Weed Seeds Maximum Permitted (percent) (Note 4.)
Clover, small hop (Trifolium dubium) (Note 5)		95	85	0.5
Dropseed, sand (Sporobolus cryptandrus)	70			2.0
Fescue, tall (Festuca arundinacea)	80			0.5
Grama, blue (Bouteloua gracilis) (Note 2)	25			
Grama, side-oats (Bouteloua curtipendula) (Note 2)	30			
Indian grass (Sorghastrum nutans) (Note 2)	35			2.0
Lespedeza, striata (Lespedeza striata)		97	90	0.5
Lespedeza, Korean (Lespedeza stipulacea) (Note 5)		97	90	0.5
Lespedeza, sericea (Lespedeza cuneata) (Note 5)		98	90	0.5
Lovegrass, sand (Eragrostis trichodes) (Note 2)	65			0.5
Lovegrass, weeping (Eragrostis curvula)	80			0.3
Millet, German foxtail (Setaria italica)		98	80	0.5
Native grasses				

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(Predominately little bluestem) (Note 2)	15			
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TABLE OF SEED SPECIFICATIONS (CONTINUED)				
Kind of Seed Common and Botanical Name	P.L.S. Index Minimum (Note 1.)	Purity Minimum (percent)	Germination Minimum (percent)	Weed Seeds Maximum Permitted (percent) (Note 4.)
Oats (<i>Avena sativa</i>)		95	80	0.5
Rye (<i>Secale cereale</i>)		90	70	0.3
Ryegrass, annual (<i>Lolium multiflorum</i>)	85			0.2
Ryegrass, perennial (<i>Lolium perenniale</i>)	85			0.2
Sudangrass (<i>Sorghum vulgare sudanense</i>)		98	80	0.5
Switchgrass (<i>Panicum virgatum</i>)	60			2.0
Wheat (<i>Triticum aestivum</i>)		96	80	0.1
Wheatgrass, western (<i>Agropyron smithii</i>) (Note 2)	56			1.0
<p>Note 1. The P.L.S. Index (Pure Live Seed Index) shall be calculated from information given on the seed tag, as follows: $P.L.S. Index = \% Purity \times (\% Germination + \% Firm Seed) / 100$. The pounds of seed shown on the Plans are stated as pounds of bulk seed. If the P.L.S. Index of any seed lot furnished exceeds the minimum P.L.S. index specified by 25 percent or more, the pounds of bulk seed to be planted will be adjusted by using the following formula:</p> $P = (S \times C) / F$ <p>Where:</p> <ul style="list-style-type: none"> P = Pounds of bulk seed to be planted S = P.L.S. Index specified C = Pounds of bulk seed specified F = P.L.S. Index furnished 				

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Note 2. The seed source shall be Oklahoma, Texas, Kansas, or New Mexico.

**TABLE OF SEED SPECIFICATIONS
(CONTINUED)**

Note 3. The seed shall have been pre-chilled and treated with potassium nitrate in accordance with the Hays Treatment Technique.

Note 4. The seed shall contain no Johnson grass seed. (This note applies to all seed.)

Note 5. The seed shall be treated with an approved nitrogen fixing inoculant, such as manufactured by commercial commercial laboratories suitable for the particular legume. The inoculants shall be stored and handled in accordance with the manufacturer's directions.

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735.05 MULCHING MATERIALS.

A. Vegetative Mulch. This material shall consist of straw or hay as specified below. It shall be free from mold or rot and shall be in a good state of preservation when used. It shall be primarily long, heavy-stemmed material. The material shall be delivered dry, in bales and shall be kept dry until applied. The mulch shall contain no seeds which are classified as "Prohibited Noxious" and shall be as free of "Restricted Noxious" as is legally allowed by the Oklahoma Department of Agriculture.

1. Straw shall be the mature stems of barley, oats, rye, or wheat from which the grain has been harvested.
2. Hay shall consist of mature weeping lovegrass, caucasian bluestem, K.R. bluestem or pure stands of the other bluestem hays. The hay shall be free from appreciable quantities of annual grass, short grass or immature tall grass.

B. Fiberglass Roving. This material shall be formed from continuous fibers drawn from molten glass, coated with a chrome complex sizing compound, collected into strands and lightly bound together into a roving without the use of clay, starch, or other deleterious substances. The roving shall be wound into a cylindrical package approximately one foot high in such a way that the roving can be continuously fed from the center of the package through an ejector driven by compressed air and expanded into a mat of glass fibers on the soil surface. The material shall contain no petroleum solvents or other agents known to be toxic to plants or animals.

The fiber glass roving shall meet the following requirements:

PROPERTY	LIMITS	TEST METHODS
Strands per Rove	56 to 64	End Count
Fibers per strand	184 to 235	
Fiber diameter	.00035-.00040 inc.	ASTM D578
Yards per pound of strand	13,000 to 14,000	ASTM D578
Yards per pound of rove	210 to 230	ASTM D578
Organic content (Percent max.)	0.75	ASTM D578
Package Weight	30-35 pounds	ASTM D578

C. Asphalt Mulch. Asphalt mulch shall be MS-2 emulsified asphalt conforming to Subsection 708.03. Before application, the mulching asphalt shall be diluted with water, in the proportion of one gallon of emulsified asphalt to 3 gallons of water.

D. Excelsior Mat. This material shall consist of a machine produced mat of wood excelsior, with the excelsior fibers interlocking to form a continuous web. At

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least 80 percent of the fibers shall be 8 inches or longer in length. The web of fibers shall be distributed uniformly throughout the mat, resulting in a mat of uniform thickness and density. The mat shall be covered on one side with extruded plastic netting which shall not exceed a mesh size of 1 inch x 2 inches. The dimension of the mat shall be as follows:

Length:	not less than 150 feet
Width:	48 inches or 60 inches + 1 inch
Dry weight:	0.8 lbs./sq. yd.

The mat shall be smolder resistant. The smolder resistant treatment shall be non-leaching, and shall be non-injurious to vegetation, animals and humans. The leaching resistance test shall be in accordance with Federal Test Method 191, Method 5830. The smolder resistance test shall be conducted after the leaching test and on the air-dried sample. The Contractor shall furnish a Type D Certification for excelsior mat material furnished.

Fasteners meeting the requirements of Subsection 735.06 B. shall be used for anchoring the mat.

E. Jute Mesh. This material shall be a uniform, open, plain weave of new and unused single jute yarn. The yarn shall be loosely twisted and shall not vary in thickness by more than one-half its normal diameter. Jute mesh shall be furnished in strips as follows:

Length:	not less than 150 feet
	78 Warp ends per width approximately.
	41 Weft ends per yard approximately.
Weight:	not less than 0.9 lb./sq. yd.

F. Excelsior Mulch. The material shall consist of wood fibers cut from sound green timber. The cut shall be made at a slight angle to the natural grain of the wood, so as to cause splintering of the fiber when weathered.

The excelsior mulch shall have the following properties: Burred wood fibers, major portion shall be approximately 4 inches long. The fiber size shall be 0.024 inches x 0.031 inches + 20 percent.

The total volatile content (moisture, etc.) at the time of manufacture shall not exceed 45 percent, as expressed by the following formula:

$$V = (a-b) \times 100/a$$

Where:

V = Percent volatile content
a = Weight of original sample

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b = Weight of dry sample

The material shall be delivered in bales. Each bale shall weigh 80-90 pounds and shall be tagged with the weight at the time of manufacture. Density of the baled material shall be 11-15 lb./cu. ft.

G. Wood Cellulose Fiber. The material shall be composed of natural wood fiber produced from wood chips. It shall contain no growth- or germination-inhibiting factors and shall contain a water soluble, non-toxic coloring agent.

H. Nylon Erosion Control Mat. Nylon erosion control mat shall consist of a bulky structure of entangled nylon monofilaments, melt-bonded at their intersections, forming a stable mat of suitable weight and configuration. The mat shall be resilient, permeable and highly resistant to environmental deterioration and ultraviolet degradation. The color of the mat shall be black and comply with the following physical properties:

1. *Material Type.* Nylon 6 plus a minimum content of 0.5% by weight of carbon black.

1.1 *Dimensions:*

Filament diameter	0.0157 in. min.
Weight	0.747 lb./sq. yd. + 7%
Thickness of mat	0.71 in. min.
Width	38.2 in. + 3%
Roll length	109 + 3.3 yd.

1.2 *Tensile Properties:*

STRENGTH	
Length dimension	282 lb./yd. min.
Width dimension	161 lb./yds. min.
ELONGATION	
Length direction	50% min.
Width direction	50% min.

Note: ASTM D 1682 strip test procedure modified to obtain filament bond strength used to indicate tensile properties.

1.3 *Resiliency:* Compression load cycling of 100 psi on a 2 in. x 2 in. sample size, crosshead speed of 2 in. per minute.

30 minute recovery (3 cycles) 80% min.

2. *Certification.* The manufacturer shall furnish a Type D Certification with each shipment of the mat material.

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3. *Mat Fasteners.* Mat fasteners meeting the requirements of Subsection 735.06 B. shall be used for anchoring the mat.
4. *Seed.* Common bermuda grass seed, unhulled, shall meet the Specification requirements of Section 735.04 of the Standard Specifications.

I. *Inspection of Materials.* Prior to delivery of mulching materials, the Contractor shall notify the Engineer of the sources from which he expects to obtain the materials and quantities he expects to obtain from each source. He shall furnish the Engineer with representative samples of the materials proposed for use. The Engineer may use the samples for provision approval prior to delivery. Evidence of wetting, caking or other deterioration at any time before use shall be cause for rejection.

If during application or after placement, the character or action of any mulching material indicates that the material cannot be applied or fastened in accordance with Specifications, it will be rejected and shall be promptly removed from project.

735.06 MULCH FASTENING MATERIALS.

- A. *Adhesive Fastener.*** The adhesive fastener shall conform to Specifications for emulsified asphalt, SS-1, Section 708.
- B. *Mat Fasteners.*** The mat fasteners shall meet the requirements for the type specified on the standard drawings.

735.07 FERTILIZER AND AGRICULTURE LIMING MATERIALS.

- A. *Fertilizer.*** This material shall be a commercial fertilizer composed of the standard materials and conforming to the grade specified. The term grade shall mean the percentages of total nitrogen, available phosphoric acid, and soluble potash, per one hundred weight respective, in accordance with the requirements of the Oklahoma Department of Agriculture.

Fertilizer furnished in standard, factory-sealed containers shall have all labeling required by the Oklahoma Department of Agriculture. The label shall be intact and legible until the contents are used.

Each vehicle load of fertilizer furnished in bulk form shall be accompanied by 2 copies of the purchase receipt, which shall be given to the Engineer upon delivery of the fertilizer. Each receipt shall show the weight, the brand name, grade of the fertilizer and the guaranteed analysis showing the minimum percentage of plant food in the fertilizer. The name and address of the person, firm, or corporation registering or guaranteeing the fertilizer with the Oklahoma Department of Agriculture shall also be shown.

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The fertilizer to be broadcast dry shall be in a pelleted or other approved granula form, and the material to be applied by power spray shall be soluble in water and uniform in suspension.

A fertilizer with an identical NPK ratio but of a higher grade than specified may be furnished, provided the application rate is adjusted to the equivalent number of pounds of each plant food element per unit of area as would have been applied with the specified grade.

In the event such a substitution is made, the following formula shall be used in determining the new application rate:

$$a = (bxc) / d$$

Where:

- a = New application rate
- b = Grade of specified fertilizer (N.P.K.)
(converted from percent to decimal)
- c = Specified application rate
- d = Grade of new fertilizer (N.P.K.)
(converted from percent to decimal)

B. Agricultural Liming Material. This material shall consist of either agricultural limestone or hydrated lime and shall meet the requirements of Section 706. When agricultural limestone is called for, 70 pounds of hydrated lime may be substituted for 100 pounds of agriculture limestone. Agriculture limestone shall not be substituted for hydrated lime.

Liming material furnished in standard factory-sealed containers shall have all labeling required by the Oklahoma Agricultural Liming Materials Act intact and legible until the contents are used.

Each vehicle load of liming material furnished in bulk form shall be accompanied by two copies of the purchase receipt. This receipt shall be given to the Engineer upon delivery of the liming material. Each receipt shall include: the name of the liming material, the brand or trade name, the net weight, the percent ECCE (Effective Calcium Carbonate Equivalent) and the name and address of the manufacturer, producer, or distributor.

The Engineer will obtain a one-quart sample from each vehicle load of bulk material to be submitted to Materials Laboratory for testing.

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736.00 PAVEMENT MARKERS

736.01 CLASS A REFLECTIVE PAVEMENT MARKERS.

A. Design and Shape. The prismatic reflectorized marker shall conform to the shape and dimensions shown on the Plans and shall be so constructed that moisture and road grime will not penetrate or damage the element. Reflector units shall be smooth throughout and made of methylmethacrylate conforming to the requirements of the Standard Specifications for Methacrylate Molding and Extrusion Compounds ASTM Designation, D788. Grade 8 shall be used unless otherwise specified. The reflector shall show no change in shape or color when subjected to the requirements of Test Method OHD-L-24 at a temperature of 140° F with the marker in the vertical position.

The marker shall be molded of methylmethacrylate conforming to Federal Specification L-P-380a, Type 1, Class 3. Filler shall be a potting compound selected for strength, resilience, and adhesion adequate to pass the necessary physical requirements. The marker shall withstand a load of 9000 pounds without breaking or being significantly deformed when tested according to Test Method OHC-L-23.

Horizontal incidence angle means the angle, in a plane parallel to the base of the marker, between a line in the direction of the incident light and a line perpendicular to the leading edge of the reflective surface.

Divergence angle means the angle at the reflector between observer's line of sight and the direction of the light incident on the marker. Specific intensity shall mean candle-power of the returned light at the chosen divergence and incidence angle for each foot-candle of incident light. Federal Test Method Standard 370 will be used to determine specific intensity.

The specific intensity of the reflector at 0.2° divergence angle shall not be less than the following when the incident light is parallel to the base of the marker:

HORIZONTAL ENTRANCE ANGLE	SPECIFIC INTENSITY		
	CRYSTAL	AMBER	RED
0°	2.5	1.5	0.6
20°	1.0	0.6	0.2

B. Sampling and Testing. A minimum of five pavement markers of each type to be used on the project shall constitute a sample. Testing shall be in accordance with testing procedures indicated in this Specification.

A Type A Certification shall be the basis of acceptance of the reflector unit.

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736.02 CLASS B NON-REFLECTIVE PAVEMENT MARKERS.

- A. Design and Shape.** Traffic Buttons shall be round and dome-shaped with a uniform curvature. The top and sides of the buttons shall be smooth and free from surface irregularities, pits, cracks, checks, chipping, discoloration, and any other defects which adversely affect appearance and application. The bottom of the buttons shall be rough-textured, free from gloss, glaze or any other substances that may reduce its bond to the adhesive.

Each traffic button shall be $4 + 1/8$ inch in diameter at the base. Height of the button shall be $11/16 + 1/16$ inch. The base of the button shall not deviate from a flat plane by more than $1/16$ inch.

- B. Physical Requirements.** The water absorption of the button shall not exceed 1.0 percent of the original dry weight when tested in accordance with ASTM C 373.

The glazed surface of the button shall not craze, spall or peel when subjected to one cycle of the autoclave test at 250 pounds per square inch in accordance with ASTM C 424.

A random sample of 5 buttons shall be subjected to the compressive load test. The average compressive strength of the 5 buttons shall not be less than 1500 pounds and no individual button shall have a compressive strength less than 1200 pounds.

The button shall be centered, base down, over the open end of a vertically positioned hollow metal cylinder. The cylinder shall be one inch high with an internal diameter of 3 inches and a wall thickness of $1/4$ inch. A load necessary to break the button shall be applied at a speed of 0.2 inch per minute to the top of the button through a one inch diameter solid metal cylinder centered on the top of the button. Should any of the samples tested for strength fail to comply with this Specification, 10 additional samples will be tested. The failure of any one of the resamples shall be cause for rejection of the entire lot or shipment represented by the samples.

The button shall not break, chip, or crack when subjected to the impact of a one pound steel ball falling freely from a height of 24 inches. Impact tests shall be performed at a temperature of 40 to 45° F with the button resting on but not bonded to a flat steel plate. Buttons shall be heat-aged a minimum of 10 days at 150° F before testing for impact resistance.

- C. Color.** The color of the buttons shall be as designated on the Plans, shall be uniform, and shall be determined by visual comparison with calibrated standards having C.I.E. Chromaticity Coordinate limits determined in accordance with Federal Methods of Tests TT-T-141, Method 4252 falling within an area having the following corner points:

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	1		2		3		4		Brightness
	X	Y	X	Y	X	Y	X	Y	(% MgO)
White	.290	.316	.310	.296	.330	.321	.310	.342	80 min.
Yellow	.470	.460	.515	.485	.545	.455	.190	.425	40 min.

D. Glaze Thickness. The glazed surface shall have a mean thickness not less than 0.005 inch when measured not closer than ¼ inch from the edge of the button. The glaze thickness shall be measured on a fractured edge of the button to the nearest 0.001 inch by a calibrated scale microscope.

E. Sampling and Testing. A minimum of ten traffic buttons selected at random will constitute a sample.

736.03 CLASS C REFLECTIVE ALL WEATHER PAVEMENT MARKERS.

A. Design and Shape. Pavement markers shall consist of an iron casting to which are attached replaceable prismatic reflectors of the type shown on the Plans and as further described in these Specifications. The forward portion(s) of the casting shall be so shaped that the blade of a snowplow, maintainer, or other highway maintenance equipment will be deflected without snagging or damaging the marker. The bottom of the casting shall incorporate anchoring devices designed to fit into the slots or grooves cut in the roadway surface. The marker shall be bonded to the roadway pavement with an approved adhesive. It shall be anchored so that the marker will not be dislodged by traffic, snowplows or other highway maintenance equipment. The casting shall be designed so that the reflector-mounting surface will be 30° to the horizontal and contain provisions for securely attaching replaceable reflectors. Provisions shall be made for fast, easy replacement of reflectors with common hand tools without disturbing the anchorage of the casting. The marker shall withstand a load of 9000 pounds without breaking or being significantly deformed when tested according to test method OHD L-23.

B. Casting. The casting of the marker shall conform to the shape and dimensions shown on the Plans and shall be a clean substantial casting, free from sand or blow holes or other defects. Surface of the castings shall be free from burnt-on sand and shall be reasonably smooth. Runners, risers, fins and other cast-on pieces shall be removed from the casting and such areas ground smooth. All corners and edges exposed to traffic shall be rounded. Casting shall be made of ductile iron and shall conform to the requirements of ASTM A 536. Grade 65-45-12 shall be used unless otherwise specified. The top of the forward rails of the casting shall have a hardness of 50-55 RC when tested by ASTM E18.

C. Reflector. The reflectors of the marker shall conform to the shape and dimensions shown on the Plans and shall be so constructed that moisture and road grime will not penetrate or damage the element. Reflector units shall be smooth throughout and made of methylmethacrylate conforming to the

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requirements of ASTM D 788. Grade 8 shall be used unless otherwise specified.

The reflector shall show no change in shape or color when subjected to the requirements of test method OHD-L-24. The temperature shall be 140° F with the marker in a vertical position.

The specific intensity of the reflector shall meet the requirements of Subsection 736.01 A.

- D. *Sampling and Testing.*** Sampling and testing shall be in accordance with Subsection 736.01 B.

736.04 ADHESIVES FOR USE WITH PAVEMENT MARKERS.

- A. *Epoxy Resin Adhesives.*** Epoxy resin adhesives used for securing Class A and Class B pavement markers to the roadway surface shall meet the requirements of AASHTO M 237. The epoxy resin adhesives used for securing Class C pavement markers shall meet the requirements of AASHTO M 237 except the viscosity may be a lower viscosity in accordance with the pavement marker manufacturer's recommendation.
- B. *Bituminous Type Hot-Melt Adhesives.*** Bituminous type hot-melt adhesives used for securing Class A and B pavement markers to the roadway surface shall meet the requirements specified on the Plans or in the special Provisions.
- C. *Sampling and Testing.*** The Contractor shall furnish a Type D certification for each batch or lot of the materials.

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737.00 CONCRETE SURFACE FINISH FOR STRUCTURES

737.01 DESCRIPTION. This Section covers materials and testing requirements for concrete surface finishing compounds for structures.

737.02 OPTION I – HEAVY CEMENT BASE MORTAR.

A. Materials.

1. Heavy cement base packaged in dry powder form for mixing with water.
 - a. Plaster mix for plaster gun application.
 - b. Brush and float mix for brush and float application.
2. *Bonding Agent.* A formulation of acrylic polymers and modifiers in liquid form for use as an additive with portland cement mixes to assure adhesion.

B. Proportioning and Consistency. The bonding agent and water shall be proportioned in accordance with the manufacturer's recommendations. A copy of those recommendations shall be furnished to the Engineer.

737.03 OPTION II – PAINT TYPE SPRAY FINISH.

A. Materials. Material for paint type spray finish shall be a textured commercial product designed specifically for this purpose.

B. Testing and Certification. Products must be qualified by the submission of a Type A Certification. The City reserves the right to discontinue approval of products that prove unsatisfactory when used in accordance with the manufacturer's instructions.

Each shipment of the satisfactorily tested product shall be accompanied by a Type C Certificate from the manufacturer.

Material to be furnished for spray finish (Option II) shall conform to the following requirements.

1. *Freeze-Thaw Cycle.* Cast and cure three concrete specimens, not less than 4 inches x 6 inches x 6 inches of the mix designed for the structure. Apply the surface finish after moist curing the specimens for 14 days and dry-curing them for 24 hours in room air at 60° - 80° F. for three hours. Caution shall be taken that there be no excessive oil on specimen forms. Coat sides of specimens (brush permitted) as hereinafter set out and cure at room temperature for 48 hours, after which:
 - a. Immerse in water at room temperature 60° to 80° F. for three hours.

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- b. Place in cold storage at -15° F. for one hour.
- c. Thaw at room temperature 60° to 80° F for one hour minimum.
- d. Repeat steps b. and c. to complete a total of 50 cycles.

At the end of 50 cycles of freeze-thaw test, the specimens shall show no visible defects.

- 2. *Accelerated Weathering.* The material shall be subjected to a 5000 hour exposure test in a twin-arc-weatherometer at an operating temperature of 145° F. The test shall be made at 20 minute cycles consisting of 17 minutes of light and 3 minutes of water spray plus light. At the end of said exposure test, the exposed sample must not show any chipping, flaking or peeling.
- 3. *Flexibility.* The material, when applied to a thin metal plate at a spreading rate to 45 + 5 square feet per gallon shall bend without breaking the film at an angle of 180 degrees over a one-inch mandrel.
- 4. *Fungus Growth Resistance.* The material to be used shall pass a fungus resistance test as described by Federal Specification TT-P-29b with a minimum incubation period of 21 days where no growth shall have been indicated after the test.
- 5. *Abrasion Test Cu. Cm./Sq. Cm.* When tested for abrasion resistance in accordance with ASTM C418, the loss shall not be greater than 0.5 cu. cm./sq. cm.
- 6. *Salt Spray Resistance.* The material, when applied to concrete at a rate of 50 square feet per gallon and tested in accordance with ASTM B117 with the coating exposed to a 5 percent sodium chloride (salt solution) for 300 hours and maintained at 90 + 2° F. during the period of exposure, shall show no loss of adhesion or deterioration at the end of the 300 hours exposure to the salt spray.

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738.00 ELECTRICAL CONDUCTORS

Description. This section covers the requirements of materials for electrical conductors of the size, type and the locations shown on the Plans or established by the Engineer in section 811 and 834.

738.01 TRAFFIC SIGNAL WIRE AND CABLE.

- A.** Traffic and Signal Electrical Cable shall comply with the requirements of the International Municipal Signal Association (IMSA) Specifications No. 19-1 or No. 20-1. The conductors shall be copper No. 14 AWG, unless otherwise shown on the Plans.
- B.** Shielded Loop Detector Lead-In Cable shall comply with the requirements of IMSA No. 50-2. The conductors shall be copper No. 14 AWG, unless otherwise shown on the Plans.
- C.** Loop Detector Wire shall comply with the requirements of IMSA No. 51-1 or IMSA No. 51-3 except, when specified on the Plans, IMSA No. 51-5 shall be used. The conductors shall be copper No. 14 AWG, unless otherwise shown on the Plans.

738.02 BUILDING AND SECONDARY DISTRIBUTION WIRE AND CABLE.

- A. General.** All conductors shall be copper and standard AWG sizes, unless otherwise shown on the Plans.
- B.** Building Wire and Cable shall comply with the applicable requirements of ASTM B 3, ASTM B 8, ASTM B 33, the National Electric Code (NEC) and be rated for 600 volts, unless otherwise specified on the Plans.
- C.** Underground Secondary Distribution Wire and Cable shall comply with the requirements of the Insulated Cable Engineers Association (ICEA)/National Electrical Manufacturer's Association (NEMA) Standard Pub. No. S-61-402/WC5 or ICEA/NEMA Standard Pub. No. S-66-524/WC 7, unless otherwise shown on the Plans.
- D.** Outdoor Aerial Neutral-Supported Secondary Distribution Wire and Cable shall comply with the requirements of ICEA/NEMA Standard Pub. No. S-66-524/WC 7, unless otherwise specified on the Plans.

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739.00 PULL BOXES

739.01 PRECAST CONCRETE PULL BOXES. Concrete pull boxes shall conform reasonably close to the dimensions shown on the Plans and to the following materials requirements.

Portland Cement. Portland cement shall meet the requirements of Subsection 701.02.

Aggregate. Aggregate shall meet the quality requirements of Section 701 or of ASTM C 330 for Lightweight Aggregate.

Reinforcement. Welded wire fabric shall comply with subsection 723.03.

Gray Iron Casting Cover. Gray iron casting covers shall comply with Subsection 725.04. The cover shall have a non-slip surface and two 3/8 inch pent head brass bolts and nuts to secure it to the box.

Concrete. The concrete mixture shall be designed to produce 3,000 pounds per square inch strength in accordance with AASTHO T 23 and AASTHO T 22.

739.02 PRECAST REINFORCED PLASTIC PULL BOXES.

A. General. Plastic pull boxes shall conform reasonably close to the dimensions shown on the Plans and to the following materials requirements.

The reinforced plastic mortar shall be composed of a borosilicate type glass fiber in the form of woven fabric, chopped strand or mat, catalyzed polyester resin and an aggregate.

Plastic pull boxes shall have the following design characteristics. The cover shall have an embossed nonskid surface and be equipped with two 3/8 inch pent head brass bolts and nuts to secure it to the box. The box and cover shall be concrete gray in color. The pull boxes shall be capable of withstanding the following loads.

1. *Cover:* 5,000 pounds distributed over a 10-inch x 10-inch area centered on the cover and shall withstand without puncture or splitting, a 75 ft./lb. impact load from a 12 lb. weight having a "C" tup in accordance with ASTM D 2444.
2. *Box Walls:* 5,000 pounds vertical load distributed over a 10 inch x inch area centered over an exposed edge of the box with the cover place.
3. *Lateral Loads:* 5,000 pounds distributed over a 10-inch x 10-inch area of backfill immediately adjacent to the box with the box in the installed condition and without the cover in place.

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Deflections resulting from loads imposed under the above-mentioned tests shall in no case cause binding of the cover or displacement from the extension.

- B. *Plastic Material.*** Plastic materials shall be self-extinguishing when tested in accordance with ASTM D 635 and show no appreciable change in physical properties when exposed to the weather.
- C. *Certification.*** A Type A Certification shall be submitted for each lot or shipment of pre-cast reinforced plastic pull boxes.

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740.00 TRAFFIC SIGNAL BACKPLATES

740.01 DESCRIPTION. This section covers the material requirements for traffic signal backplates.

A. *Materials.* Backplates shall be constructed from sheet material of polycarbonate or acrylonitrile-butadiene-styrene (ABS).

1. Polycarbonate sheet material shall conform to the requirements of ASTM D 638, D 695, D 790 and D 1822.
2. ABS sheet material shall conform to ASTM D 1788.
3. The thickness of the backplates shall be as shown on the Plans.

B. *Finish.* The backplate shall be black in color with a haircell finish on the front side and smooth finish on the back side.

C. *Certification.* A Type A Certification shall be submitted for each lot or shipment of backplates.