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**Special Project Specifications**  
**for**  
**Construction**  
**of**  
**Roads and Bridges**

**DIVISION 700 - Materials**

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## **DIVISION 700 - Materials**

## **Section 701 - Cement, Grout, & Mortar**

### **701.01 Cement**

Ensure that cement meets requirements in the following specifications:

**(a) Portland Cement.** Ensure that Portland cement meets requirements specified in AASHTO M 85.

**(b) Blended Hydraulic Cements, Excluding Types S & SA.** Ensure that they meet requirements specified in AASHTO M 240.

**(c) Masonry Cement.** Ensure that masonry cement meets requirements specified in ASTM C 91.

Fly ash or pozzolan may be substituted for Portland cement, provided the proportions of cement and fly ash or pozzolan conform to the requirements specified in Section 552 or 602.

When blended cement (AASHTO M 240) is proposed for use, meet all requirements for fly-ash-modified concrete in the applicable sections.

Ensure that fly ash or pozzolan materials conform to the requirements specified in Subsection 725.04.

Use the product of only one manufacturing plant and only one brand of any one type of Portland cement on the project.

Store the cement and protect it against dampness. Reject cement that for any reason has become partially set or that contains lumps of caked cement. Do not use cement salvaged from discarded or used bags.

### **701.02 High-Strength Nonshrink Grout**

Furnish grout that is packaged and ready for use with the addition of water at the construction site. Ensure that each bag is stamped to show the last date on which it may be used. Use grout that consists of a hydraulic cementitious system, graded and processed natural fine aggregate, and additional technical components such that the product meets the following conditions:

- (a) It is free of inorganic accelerators, including chlorides.
- (b) It is free of oxydizing catalysts.
- (c) It is free of gas-producing agents.

- (d) When mixed to 130 percent flow on flow Table (ASTM C 230 at 10 drops), it does not reduce in linear dimension when tested in accordance with ASTM C 157. Take measurements at 72 hours and 7 days.
- (e) It produces no bleeding for the first 2 hours after mixing when mixed to 130 percent flow on flow Table (ASTM C 230 at 10 drops), as tested in accordance with ASTM C 232.
- (f) It has a minimum strength as follows when tested in accordance with ASTM C 109:
  - (1) After 72 hours, 3,500 psi
  - (2) At 7 days, 5,500 psi
  - (3) After 28 days, 7,000 psi

Provide performance characteristics at 115 to 120 percent flow on flow Table (ASTM C 230 at 10 drops).

- (g) It must be designed, as stated by the manufacturer, to be mixed, placed, and cured at atmospheric temperatures of 40 °F to 86 °F. Submit products proposed for use for approval by the CO, and accompany them with manufacturer’s submittals substantiating all requirements in this subsection, including graphs or charts showing the time, temperature, and humidity requirements for curing to achieve the specified grout strengths; and recommendations for storage, mixing, application, and curing procedures.

**701.03 Low-Strength Grout**

Furnish grout mixtures that conform to the following for the type or types SHOWN ON THE DRAWINGS:

**(a) Hydraulic Cement Grout.** Furnish a mixture of Portland cement, fine aggregate, water, expansive admixture, and/or fly ash such that the product meets the following requirements:

- (1) 7-day compressive strength, AASHTO T 106 .....600 psi minimum.
- (2) Flow, FLH T 502 or ASTM C 939, conforming to the following:
  - (a) Time of efflux<sup>1</sup> .....16 to 26 seconds

<sup>1</sup>A more fluid mix having a flow cone time of efflux from 9 to 15 seconds may be used during initial injection.

Submit the following with the Certificate of Compliance:

- Mill certifications for the cement.
- Physical and chemical analysis for the pozzolans.
- Independent laboratory test results (1-day, 3-day, and 7-day strengths, flow cone times, shrinkage and expansion observed, and time of initial set).

**(b) Plaster Mix (Grout).** Ensure that plaster mix (grout) conforms to the following:

- (1) Adhesive strength, 28-day, sheer bond adhesion testing method.....300 psi minimum.
- (2) Freeze-thaw resistance, ASTM C 666, method B.....No cracks or delamination after 300 cycles
- (3) Accelerated weathering, 5,000-hour .....No visible defects
- (4) Slat spray resistance, 300-hour.....No deterioration or loss of adhesion
- (5) Absorption, ASTM C 67 .....3.5% max.
- (6) Flexural strength, ASTM C 348, 28-day.....1,000 psi minimum.
- (7) Compressive strength, AASHTO T 106, 28-day .....4,000 psi minimum.

**(c) Portland Cement Grout.** Furnish one part Portland cement and three parts sand. Thoroughly mix with water to produce a thick, creamy consistency.

#### **701.04 Mortar**

Furnish mortar that is packaged and ready for use with the addition of water at the construction site. Ensure that each bag is stamped to show the latest date on which it may be used. Use mortar that consists of a cementitious system made up of:

- (a) Natural aggregate, 3/8 inch in maximum size, that meets the requirements specified in ASTM C 33 except for grading. Accomplish grading by blending sieve sizes to obtain the optimum density.
- (b) Metallic aggregate free from nonferrous material, soluble alkaline compounds, and visible rust.
- (c) Water reducers, workability agents, air-entraining agents, and catalysts.

Blend the materials to minimize bleeding, increase workability, resist exposure to freeze-thaw cycles and deicing salts, and prevent shrinkage within and at the perimeter of the patch, keyway, or other area to be filled.

Ensure that the minimum compressive strength of the mortar, as tested by ASTM C 109 for a 3 inch slump, is:

- 24-hour .....5,000 psi
- 7-day .....9,000 psi
- 28-day .....10,000 psi

Ensure that the durability of the products when tested at 300 cycles, ASTM C 666, procedure A, is:

<b>Submerged in:</b>	<b>DF (%)</b>
Water	98
5% CaCl <sub>2</sub> solution	95
5% NaCl solution	85

Ensure that the scaling resistance has a rating of 3, Moderate Scaling, after 50 cycles when tested in accordance with ASTM C 672.

Provide certification from the manufacturer that the product is compatible for work that is 1 inch or more in depth and more than 1 inch in width; and where the mixing, placing, and curing temperatures may range from 40 °F to 86 °F.

Submit products proposed for use to the CO for approval, and accompany them with the manufacturer’s submittals substantiating all requirements in this section, including (1) graphs or charts showing the time, temperature, humidity, and curing requirements to achieve mortar strengths equal to the adjacent concrete; and (2) complete recommendations for storage, mixing, application, and curing procedures.

**701.05 Polymer Grout**

Furnish a polymer binder and fine aggregate in the proportions recommended by the polymer manufacturer with a minimum compressive strength of 3,500 PSI in 4 hours.



- (4) Tests on residue from distillation:
- (a) Penetration, 77 °F, 3.5 oz., 5-second, AASHTO T 49 .....1.5 inches  
– 4.0 inches
  - (b) Solubility in trichloroethylene, AASHTO T 44 .....97.5% min.
  - (c) Ductility, 77 °F, 2 inches per minute, AASHTO T 51 .....4.0 inches min.

**(e) CRS–2 Polymer-Modified Emulsions.** Ensure that polymer-modified emulsions conform to the following:

- (1) Viscosity, 122 °F, Saybolt Furol .....100 to 400 seconds
- (2) Storage stability test after 24 hours .....1.0% max.
- (3) Demulsibility .....40% min.
- (4) Particle charge .....Positive
- (5) Sieve test .....0.3% max.
- (6) Residual by distillation .....65% max.
- (7) Oil distillate by volume of emulsion .....3% max.
- (8) Test on residue from distillation:
  - (a) Penetration, 77 °F, 100 g, 5-second .....3.5 inches – 8 inches
  - (b) Solubility in trichloroethylene .....97.5% min.
  - (c) Torsional recovery, CAL TRANS test no. 332 .....18% min.  
or toughness/tenacity ft-lb<sup>1</sup> .....4.1/2.1 min.

<sup>1</sup> Benson Method of Toughness and Tenacity, Scott tester, in-lbs at 77 °F, 20-inches per minute pull. Tensionhead 7/8 inches diameter (ASTM D 4, proposed P 243).

Ensure that polymer is milled into the emulsion during the manufacturing process.

#### **702.04 Application Temperatures**

Apply asphalts within the temperature ranges shown in Table 702-1.

#### **702.05 Recycling Agent**

Use recycling agents that conform to ASTM D 4552, or use a preapproved petroleum product additive that restores aged asphalt to the required specifications.

Table 702-1. - Application temperatures, range (°F).		
Type and Grade of Asphalt	Temperature Ranges (minimum – maximum)	
	Spraying Temperatures	Mixing Temperatures <sup>b</sup>
<b>Cutback asphalt:</b>		
MC-30	85 <sup>a</sup>	-
RC, MC, or SC-30	120 <sup>a</sup>	-
RC, MC, or SC-250	165 <sup>a</sup>	140 - 175 <sup>c</sup>
RC, MC, or SC-800	200 <sup>a</sup>	165 – 210 <sup>c</sup>
RC, MC, or SC-3000	230 <sup>a</sup>	180 – 240 <sup>c</sup>
<b>Emulsified asphalt:</b>		
<b>RS-1</b>	70 – 140	-
RS-2	120 – 185	-
MS-1	70 – 160	70 – 160
MS-2, -2h	-	70 – 160
HFMS-1, -2, -2h, -2s	70 - 160	50 – 160
SS-1, -1h; CSS-1, 1h	70 – 160 <sup>d</sup>	70 – 160
CRS-1, 1h	120 – 185	-
CRS-2, 2h, -2 modified	140 - 185	-
CMS-2, -2h	100 - 160	120 – 140
Asphalt cement - all grades	350 max.	350 max.
<p>a. The maximum temperature at which fogging or foaming does not occur.  b. Temperature of mix immediately after discharge.  c. Temperature may be above flash point. Take precautions to prevent fire or explosion.  d. For fog seals and tack coats.</p>		

**702.06 Asphalt Mastic**

Use asphalt mastic that conforms to AASHTO M 243.

**702.07 Antistrip Additive**

- (a) Furnish commercially produced heat-stable liquid products that have the chemical and physical properties when added to an asphalt to prevent separation of the asphalt from aggregates.
- (b) Furnish cement that conforms to Subsection 701.01 or fly ash that conforms to Subsection 725.04.
- (c) Furnish hydrated lime conforming to Subsection 725.03.

**702.08 Cold Asphalt Concrete**

Provide an asphalt concrete mixture composed of crushed stone or gravel and asphalt cement mixed in an approved plant. Ensure that the gradation and quality of the aggregate and the grade and quality of asphalt binder conform to those normally used in the construction of highways by Federal or State agencies.

Do not use an aggregate asphalt mixture that strips. Use an asphalt grade that leaves the mix pliable and workable at a temperature of 14 °F.

## **Section 703 - Aggregate**

### **703.01 Fine Aggregate for Portland Cement Concrete**

As fine aggregate, use sand that conforms to the requirements shown below.

- (a) For structural concrete, fine aggregate is sand that conforms to AASHTO M 6, Class B, but limit the material that passes the No. 200 sieve to 3.0 percent. Also meet the supplementary requirements of AASHTO M 6 for reactive aggregates. Use material that conforms to sand equivalent value, AASHTO T 176, alternate method number 2, 75 minimum.
- (b) For structural concrete, lightweight fine aggregate is sand that conforms to AASHTO M 195, where applicable.
- (c) For minor concrete structures, meet requirements specified in AASHTO M 6.

### **703.02 Coarse Aggregate for Portland Cement Concrete**

Furnish coarse aggregate that conforms to the requirements listed below.

- (a) For structural concrete, furnish coarse aggregate that conforms to AASHTO M 80, Class A, but use aggregates with a percentage of wear that is not more than 40 percent, in accordance with AASHTO T 96. In concrete used in bridge decks or for paving, do not use aggregates known to polish, or carbonate aggregates containing by weight less than 25 percent insoluble residue, as determined by ASTM D 3042.

Ensure that the adherent coating on the aggregate does not exceed 1.0 percent when tested in accordance with FLH T 512.

- (b) For structural concrete, furnish lightweight coarse aggregate that conforms to AASHTO M 195, when applicable.
- (c) For minor concrete structures, aggregate must meet AASHTO M 80 and the Class designations that are appropriate for end use and weathering exposure.

### **703.03 Granular Backfill**

**(a) Coarse Granular Backfill.** Furnish backfill material that conforms to AASHTO M 80, Class E, and AASHTO M 43, grading no. 3, 4, 5, 7, 57, or 67. Minor variations in the gradation and the deleterious substance content are subject to approval by the CO.

**(b) Fine Granular Backfill.** Furnish backfill material that conforms to AASHTO M 6. The soundness test is not required. Minor variations in the gradation and the deleterious substance content are subject to approval by the CO.

### **703.04 Sheathing Material**

Furnish either fine aggregate meeting gradation requirements of AASHTO M 6, or coarse aggregate consisting of sound, durable particles of gravel, slag, or crushed stone, as specified in Table 703-1.

Table 703-1. – Sheathing material gradation.	
Sieve Designation (inch)	% by Weight Passing Standard Sieves (AASHTO T 11 and T 27)
3	100
$\frac{3}{4}$	50 - 90
No. 4	20 - 50
No. 200	0.0 - 2.0

**703.05 Subbase, Base, & Surface Course Aggregate**

**(a) General.** Furnish aggregates that consist of hard, durable particles or fragments of crushed stone, crushed slag, or crushed gravel meeting the appropriate gradation, as shown in Table 703-2 or 703-3, and conforming to the following:

- (1) Los Angeles abrasion, AASHTO T 96 .....40% max.
- (2) Sodium sulfate soundness loss (five cycles),  
AASHTO T 104 .....12% max.
- (3) Durability index (coarse), AASHTO T 210 .....35 min.
- (4) Durability index (fine), AASHTO T 210 .....35 min.
- (5) Fractured faces, FLH T 507 .....50% min.

Furnish a material that is free from organic matter and lumps or balls of clay. Do not use material that breaks up when alternately frozen and thawed or wetted and dried.

Obtain the aggregate gradation by crushing, screening, and blending processes as necessary. Ensure that fine aggregate (material passing the No. 4 sieve) consists of natural or crushed sand and fine mineral particles.

**(b) Subbase & Base Aggregates.** Furnish subbase or base aggregate that conforms to specifications in Subsection 703.05(a), and to the following:

- (1) Liquid limit, AASHTO T 89 .....25 max.
- (2) Plastic limit, AASHTO T 90 .....Nonplastic

Table 703-2. - Gradation TV ranges for subbase and base.

Sieve Size (inch)	% by Weight Passing Designated Sieve (AASHTO T 27 and T 11)				
	Grading Designation				
	A (Subbase)	B (Subbase)	C (Subbase)	D (Subbase)	E (Subbase)
2 ½	100	-	-	-	-
2	97-100	100	100	-	-
1 ½	-	97-100	97-100	100	-
1	65-79 (6)	-	-	97-100	100
¾	-	-	67-81 (6)	-	97-100
½	45-59 (7)	-	-	-	-
3/8	-	-	-	56-70 (7)	67-79 (6)
No. 4	28-42 (6)	40-60 (8)	33-47 (6)	39-53 (6)	47-59 (7)
No. 40	9-17 (4)	-	10-19 (4)	12-21 (4)	12-21 (4)
No. 200	4.0-8.0 (3)	0.0-12.0 (4)	4.0-8.0 (3)	4.0-8.0 (3)	4.0-8.0 (3)

Note: Allowable deviations (±) from TV are shown in parentheses.

Table 703-3. - Gradation TV ranges for surface courses.

Sieve Size (inch)	% by Weight Passing Designated Sieve (AASHTO T 27 and T 11)	
	Grading Designation	
	F	G
1 ½	100	-
1	97-100	100
¾	76-89 (6)	97-100
3/8	56-68 (6)	70-80 (6)
No. 4	43-53 (7)	51-63 (7)
No. 16	23-32 (6)	28-39 (6)
No. 40	15-23 (4)	19-27 (5)
No. 200	10-16 (4)	10-16 (4)

Note: Allowable deviations (±) from TV are shown in parentheses. If the plasticity index (PI) is greater than 0, the TV range for the No. 200 sieve size is 6-12 (± 4).

**(c) Surface Course Aggregate.** Furnish surface course aggregate that conforms to specifications in Subsection 703.05(a), and to the following:

(1) Liquid limit, AASHTO T 89 .....35 max.

(2) Plasticity index, AASHTO T 90:

(a) If the percent passing the No. 200 inch sieve is less than 12% .....2 to 9

(b) If the percent passing the No. 200 inch sieve is greater than 12% .....0

Do not furnish material that contains asbestos fibers.

**703.06 Crushed Aggregate**

Furnish crushed hard, durable particles or fragments of stone or gravel meeting the size and quality requirements for crushed aggregate material normally used locally in the construction and maintenance of highways by Federal or State agencies.

Furnish crushed aggregate with a maximum size of 1 inch as determined by AASHTO T 27 and AASHTO T 11. Furnish crushed aggregate that is uniformly graded from coarse to fine and is free of organic matter and lumps or balls of clay.

**703.07 Hot Asphalt Concrete Pavement Aggregate**

Aggregate for hot asphalt concrete pavement consists of hard, durable particles or fragments of crushed stone, crushed slag, or crushed gravel.

Size, grade, and combine the aggregate fractions for the mixture in proportions such that the resulting composite blend conforms to the gradation shown in Table 703-4 for the grading designated.

Furnish a blend that is reasonably free from organic or other deleterious material and does not contain more than 1.0 percent clay lumps and friable particles when tested in accordance with AASHTO T 112.

Local State department of transportation requirements for gradation and quality of hot asphalt concrete pavement may be substituted for the above requirements when DESIGNATED IN THE SCHEDULE OF ITEMS.

**(a) Coarse Aggregate.** Coarse aggregate (aggregate retained on the No. 4 sieve) consists of crushed stone, crushed slag, or crushed gravel that conforms to the following:

- (1) Los Angeles abrasion, AASHTO T 96 .....40% max.
- (2) Sodium sulfate soundness loss (five cycles),  
AASHTO T 104 .....12% max.
- (3) Fractured faces, FLH T 507 .....75% min.
- (4) Durability index (coarse), AASHTO T 210 .....35 min.

Do not use aggregates known to polish, or carbonate aggregates containing by weight less than 25 percent insoluble residue when tested in accordance with ASTM D 3042.

Table 703-4. - Aggregate gradation requirements for hot asphalt concrete pavement.

Sieve Size (inch)	% by Weight Passing Designated Sieve (AASHTO T27 and T-11)			
	Grading Designation			
	A	B	D	F
2	-	-	-	-
1 ½	100	-	-	-
1	97-100	100	-	-
¾	-	97-100	100	-
½	-	76-88	97-100	-
3/8	53-70	-		100
No. 4	40-52	49-59	57-69	33-47
No. 8	25-39	36-45	41-49	7-13
No. 30	12-22	20-28	22-30	-
No. 50	8-16	13-21	13-21	-
No. 200	3-8	3-7	3-8	2-4

**(b) Fine Aggregate.** Fine aggregate (aggregate that passes a No. 4 sieve) consists of natural sand, stone screenings, slag screenings, or a combination thereof conforming to AASHTO M 29. Exclude the grading requirements and include the sodium sulfate soundness test and the following:

- (1) Durability index (fine), AASHTO T 210 .....35 min.
- (2) Sand equivalent value, AASHTO T 176,  
alternate method number 2.....45 min.

**(c) Lightweight Aggregate (Slag).** Only use crushed slag that conforms to the quality requirements specified in AASHTO M 195. Other kinds or types of lightweight aggregates covered in AASHTO M 195 are not permitted.

**703.08 Cold Asphalt Concrete Pavement Aggregate**

Furnish aggregate for cold asphalt concrete pavement consisting of hard, durable particles or fragments of crushed stone, crushed slag, or crushed gravel.

Size, grade, and combine the aggregate fractions for the mixture in proportions such that the resulting composite blend conforms to the applicable gradation requirements shown in Table 703-5 for dense-graded mixtures and Table 703-6 for open-graded mixtures.

Ensure that the composite blend is reasonably free from organic or other deleterious material and contains less than 1.0 percent clay lumps and friable particles when tested in accordance with AASHTO T 112.

**(a) Coarse Aggregate.** Furnish coarse aggregate consisting of crushed stone, crushed slag, or crushed gravel that conforms to the following:

- (1) Los Angeles abrasion, AASHTO T 96 .....40% max.

- (2) Sodium sulfate soundness loss (five cycles),  
AASHTO T 104 .....12% max.
- (3) Fractured faces, FLH T 507 .....75% min.
- (4) Durability index (coarse), AASHTO T 210 .....35 min.

Do not use aggregates known to polish, or carbonate aggregates containing by weight less than 25 percent insoluble residue, in accordance with ASTM D 3042.

**(b) Fine Aggregate.** Furnish fine aggregate consisting of natural sand, stone screenings, slag screenings, or a combination thereof conforming to AASHTO M 29. Exclude the grading requirements and include the sodium sulfate soundness test and the following:

- (1) Durability index (fine), AASHTO T 210 .....35 min.
- (2) Sand equivalent value, AASHTO T 176, alternate  
method number 2 .....35 min.

**703.09 Asphalt Surface Treatment Aggregate**

Furnish aggregate for single and multiple surface treatment courses consisting of hard, durable particles or fragments of crushed stone, crushed slag, or crushed gravel.

Size, grade, and combine the aggregate fractions to conform to specifications in Table 703-7 for the gradation designated. Ensure that the composite blend is reasonably free from organic or other deleterious material and contains less than 1.0 percent clay lumps and friable particles when tested in accordance with AASHTO T 112.

Use only one type of aggregate on a project, and ensure that aggregates meet the following quality requirements:

- (a) Los Angeles abrasion, AASHTO T 96 .....40% max.
- (b) Sodium sulfate soundness loss, AASHTO T 104 .....12% max.
- (c) Loose unit weight shoveling procedure,  
AASHTO T 19 .....70 lb/ft<sup>3</sup> min.
- (d) Coating and stripping of bitumen-aggregate mixtures,  
AASHTO T 182<sup>1</sup> .....95% min.
- (e) Fractured faces, FLH T 507 .....75% min.
- (f) Flakiness index, FLH 508 .....30 max.

Table 703-5. - Aggregate gradation requirements and TV ranges for dense-graded cold bituminous pavement.

Sieve Size (inch)	% by Weight Passing Designated Sieve (AASHTO T27 and T-11)				
	Grading Designation				
	DA	DB	DC	DD	DE
2	100	-	-	-	-
1 ½	95-100	100	-	-	-
1	-	95-100	100	-	-
¾	60-80 (7)	-	95-100	100	-
½	-	60-80 (7)	-	95-100	100
3/8	-	-	60-80 (7)	-	95-100
No. 4	20-55 (7)	25-60 (7)	35-65 (7)	45-70 (7)	60-80 (7)
No. 8	10-40 (6)	15-45 (6)	20-50 (6)	25-55 (6)	35-65 (6)
No. 50	2-16 (4)	3-18 (4)	3-20 (4)	5-20 (4)	6-25 (4)
No. 200	0-5 (3)	1-7 (3)	2-8 (3)	2-9 (3)	2-10 (3)

Note: Allowable deviations (±) from TV are shown in parentheses.

Table 703-6. - Aggregate gradation requirements and TV ranges for open-graded cold bituminous pavement.

Sieve Size(inch)	% by Weight Passing Designated Sieve (AASHTO T27 and T-11)			
	Grading Designation			
	OA	OB	OC	OD
1 ½	100	-	-	-
1	95-100	100	-	-
¾	-	95-100	100	-
½	25-65 (7)	-	95-100	100
3/8	-	20-55 (7)	35-40 (7)	85-100 (7)
No. 4	0-10 (5)	0-10 (5)	-	-
No. 8	0-5 (3)	0-5 (3)	3-7 (3)	-
No. 16	-	-	-	0-5 (3)
No 200	0-2 (1)	0-2 (1)	0-1 (1)	0-2 (1)

Note: Allowable deviations (±) from TV are shown in parentheses.

(g) Durability index (coarse), AASHTO T 210 .....35 min.

(h) Durability index (fine), AASHTO T 210 .....35 min.

(i) Adherent coating on the aggregate, FLH T 512 .....0.5% max.

<sup>1</sup>An approved chemical additive may be used to meet this requirement.

Do not use lightweight aggregate as defined in AASHTO M 195.

Table 703-7. - Aggregate gradation requirements for single- and multiple-course surface treatments.						
Sieve Size (inch)	% by Weight Passing Designated Sieve (AASHTO T 27 and T 11)					
	Grading Designation					
	A	B	C	D	E	F
1 ½	100	-	-	-	-	-
1	90-100	100	-	-	-	-
¾	0-35	90-100	100	-	-	-
½	0-8	0-35	90-100	100	-	-
3/8	-	0-12	0-35	85-100	100	100
No. 4	-	-	0-12	0-35	85-100	85-100
No. 8	-	-	-	0-8	0-23	-
No. 200	0-2	0-2	0-2	0-2	0-2	0-10

### 703.10 Slurry Seal Aggregate

For slurry seals, furnish aggregate that is a natural or manufactured sand, slag, crushed fines, or other mineral aggregate conforming to Table 703-8 and the following:

- (a) Los Angeles abrasion, AASHTO T 96 .....35% max.
- (b) Sand equivalent value, AASHTO T 176, alternate method number 2 .....45 min.
- (c) Sand content by weight of total combined aggregate with < 1.25% water absorption .....50% max.
- (d) Sodium sulfate soundness loss, AASHTO T 104 .....12% max.
- (e) Fine durability index, AASHTO T 210 .....60% max.

Ensure that aggregate gradation is as shown in Table 703-8 for the type specified.

### 703.11 Choker Aggregate

Furnish aggregate for choker consisting of hard durable particles or fragments of crushed gravel or crushed stone meeting the gradation shown in Table 703-9. Furnish a material that is free from organic matter and clay balls and has a minimum sand equivalent value of 75, as determined by AASHTO T 176, referee method.

### 703.12 Blotter

Furnish aggregate for blotter material consisting of sound, durable particles of gravel or crushed stone with a gradation such that all particles will pass a sieve with 3/8 inch square openings. Furnish material that is free from organic matter and has a liquid limit, established by AASHTO T 89, of less than 25.

### 703.13 Aggregate for Lean Concrete Backfill

Furnish hard, clean, durable, nonplastic, nonorganic, nonreactive aggregate.

### 703.14 Superpave Asphalt Concrete Pavement Aggregate

Furnish hard, durable particles, or fragments of crushed stone, crushed slag, or crushed gravel conforming to the following:

- (a) Los Angeles abrasion, AASHTO T 96 .....35% max.
- (b) Sodium sulfate soundness loss,  
AASHTO T 104 (five cycles).....12% max.
- (c) Durability index, AASHTO T 210 (coarse and fine) .....35 min.
- (d) Fractured faces, FLH T 507 .....55 min.
- (e) Sand equivalent value, AASHTO T 176,  
alternate method number 2.....40 min.
- (f) Size, grade, and combine the aggregate fractions for the mixture in proportions such that the resulting composite blend is located between the control points for the appropriate nominal maximum size of aggregate shown in Table 703-10, 703-11, or 703-12, and Figure 703-1, 703-2, or 703-3. The nominal maximum size is one sieve size greater than the first sieve to retain more than 10 percent of the combined aggregate. Use the appropriate Table and figure in accordance with the nominal maximum size of aggregate. The gradation should not pass through the restricted zone when plotted. Test in accordance with AASHTO T 11 and T 27.

Table 703-8. - Slurry seal aggregate gradation requirements and application rates.<sup>a</sup>

Sieve Size (inch)	% by Weight Passing Designated Sieve (AASHTO T 27 and T 11)		
	Type of Slurry Seal		
	I	II	III
3/8	-	100	100
No. 4	100	90-100	70-90
No. 8	90-100	65-90	45-70
No. 16	65-90	45-70	28-50
No. 30	40-65	30-50	19-34
No. 50	25-42	18-30	12-25
No. 100	15-30	10-21	7-18
No. 200	10-20	5-15	5-15
Application rate (lb/yd <sup>2</sup> )	6-10	10-15	≥15

<sup>a</sup> Based on the dry weight of the aggregate.

Table 703-9. - Choker aggregate gradation.

Sieve Size (inch)	% by Weight Passing Designated Sieve (AASHTO T 27 and T 11)
3/8	100
No. 4	70-100
No. 200	0.0-5.0

Table 703-10. - Superpave requirements for 1/2-inch nominal size aggregate.

Sieve size (inch)	Control Points		0.45 Chart Max. Density	Restricted Zone		TV's	Allowable Deviation <sup>b</sup>
				Minimum Boundary	Maximum Boundary		
3/4		100.0	100.0				
1/2	100.0	90.0	82.8				
3/8			73.2				
No. 4			53.6			- <sup>a</sup>	6
No. 8	58.0	28.0	39.1	39.1	39.1	- <sup>a</sup>	6
No. 16			28.6	25.6	31.6		
No. 30			21.1	19.1	23.1	- <sup>a</sup>	4
No. 50			15.5	15.1	15.1	- <sup>a</sup>	3
No. 100			11.3				
No. 200	10.0	2.0	8.3			- <sup>a</sup>	2

<sup>a</sup>. Establish TV's as part of the job-mix formula. Establish aggregate gradation TV's to the nearest 0.1 percent.

<sup>b</sup>. Plus or minus from established TV's.

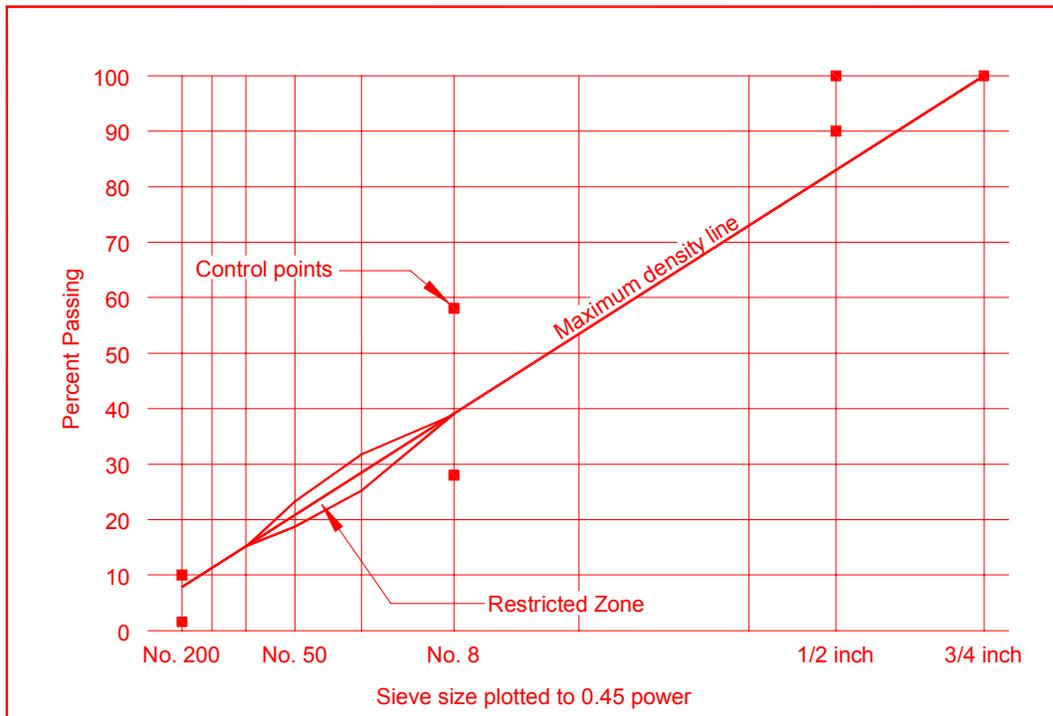


Figure 703-1. – Gradation chart for 1/2 inch nominal size aggregate.

Table 703-11. - Superpave requirements for 3/4-inch nominal size aggregate.

Sieve size (inch)	Control Points		0.45 Chart Max. Density	Restricted Zone		TV's	Allowable Deviation <sup>b</sup>
				Minimum Boundary	Maximum Boundary		
1		100.0	100.0				
3/4	100.0	90.0	88.4				
1/2			73.2				
3/8			64.7				
No. 4			47.4			- <sup>a</sup>	6
No. 8	49.0	23.0	34.6	34.6	34.6	- <sup>a</sup>	6
No. 16			25.3	22.3	28.3		
No. 30			18.7	16.7	20.7	- <sup>a</sup>	4
No. 50			13.7	13.7	13.7	- <sup>a</sup>	3
No. 100			10.0				
No. 200	8.0	2.0	7.3			- <sup>a</sup>	2

<sup>a</sup>. Establish TV's as part of the job-mix formula. Establish aggregate gradation TV's to the nearest 0.1 percent.  
<sup>b</sup>. Plus or minus from established TV's.

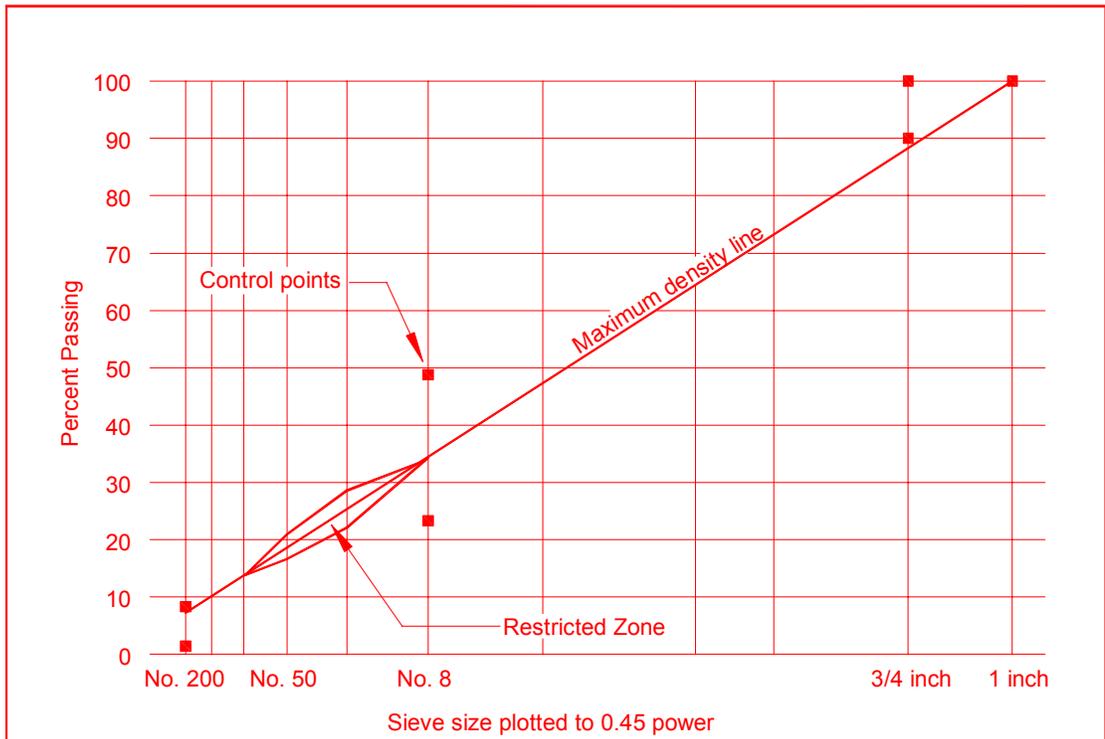


Figure 703-2. – Gradation chart for 3/4 inch nominal size aggregate.

Table 703-12. - Superpave requirements for 1-inch nominal size aggregate.

Sieve size (inch)	Control Points		0.45 Chart Max. Density	Restricted Zone		TV's	Allowable Deviation <sup>b</sup>
				Minimum Boundary	Maximum Boundary		
1 1/2	-	100.0	100.0	-	-	-	-
1	100.0	90.0	83.3	-	-	-	-
3/4	-	-	73.6	-	-	-	-
1/2	-	-	61.0	-	-	-	-
3/8	-	-	53.9	-	-	-	-
No. 4	-	-	39.5	39.5	39.5	- <sup>a</sup>	6
No. 8	45.0	19.0	28.8	26.8	30.8	- <sup>a</sup>	6
No. 16	-	-	21.1	18.1	24.1	-	-
No. 30	-	-	15.6	13.6	17.6	- <sup>a</sup>	4
No. 50	-	-	11.4	11.4	11.4	- <sup>a</sup>	3
No. 100	-	-	8.3	-	-	-	-
No. 200	7.0	1.0	6.1	-	-	- <sup>a</sup>	2

<sup>a</sup>. Establish TV's as part of the job-mix formula. Establish aggregate gradation TV's to the nearest 0.1 percent.  
<sup>b</sup>. Plus or minus from established TV's.

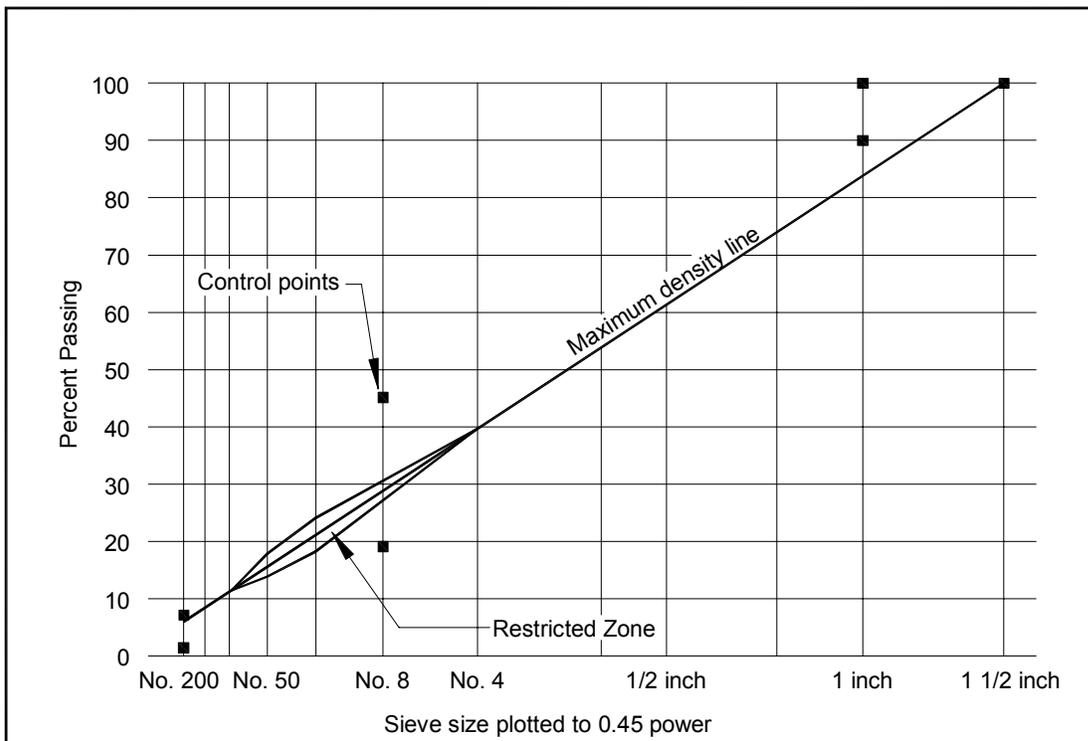


Figure 703-3. – Gradation chart for 1-inch nominal size aggregate.

**Section 704 - Soil**

**704.01 Foundation Fill**

Furnish granular material free of excess moisture, frozen lumps, roots, sod, and other deleterious material and conforming to the following:

- (a) Material passing 2 inch sieve .....100%
- (b) Soil classification, AASHTO M 145 .....A-1-a
- (c) In wet environments, material passing No. 200 .....6% max.

**704.02 Bedding**

Furnish material that conforms to the following for the Class specified:

**(a) Class A Bedding.** Furnish concrete in accordance with specifications in Section 602.

**(b) Class B Bedding.** Furnish approved sand or selected sandy soil free of excess moisture, muck, frozen lumps, roots, sod, and other deleterious material, and conforming to the following:

- (1) Material passing 3/8 inch sieve .....100%
- (2) Material passing No. 200 sieve,  
AASHTO T 27 and T 11 .....10% max.

**(c) Class C Bedding.** Furnish approved sand or fine granular material free of excess moisture, muck, frozen lumps, roots, sod, and other deleterious material. Remove all rock particles and hard earth clods larger than 1 1/2 inches.

**704.03 Backfill Material**

Furnish granular material or fine compatible soil free of excess moisture, muck, frozen lumps, roots, sod, and other deleterious material. Remove all rock particles and hard earth clods larger than 3 inches in the longest dimension.

**704.04 Structural Backfill**

Furnish free-draining granular material free of excess moisture, muck, frozen lumps, roots, sod, and other deleterious material. Remove all rock particles and hard earth clods larger than 3 inches in the longest dimension. Ensure that material conforms to the following:

- (a) Material passing No. 200 sieve,  
AASHTO T 27 and T 11 .....15% max.
- (b) Liquid limit, AASHTO T 89 .....30 max.

**704.05 Topping**

Furnish a granular material free of excess moisture, muck, frozen lumps, roots, sod, and other deleterious material. Remove all rock particles larger than 4 inches in the longest dimension. Ensure that material conforms to AASHTO M 145, Table 2, soil classification A-1 or A-3.

**704.06 Unclassified Borrow**

Furnish granular material free of excess moisture, muck, frozen lumps, roots, sod, and other deleterious material. Remove all rock fragments and boulders greater than 24 inches in the longest dimension. Ensure that material conforms to AASHTO M 145, Table 2, soil classification A-1, A-3, or A-2-4.

**704.07 Select Borrow**

Furnish crushed, partially crushed, or natural material free of excess moisture, muck, frozen lumps, roots, sod, and other deleterious material. Ensure that material conforms to the following:

- (a) Gradation .....Table 704-1
- (b) Liquid limit, AASHTO T 89 .....30 max.

Table 704-1. - Select borrow gradation.	
Sieve Size (inch)	Percent by Weight Passing Designated Sieve (AASHTO T 27 and T 11)
3	100
1	70-80
No. 4	30-70
No. 100	0-15

**704.08 Select Topping**

Furnish crushed, partially crushed, or natural material free of excess moisture, muck, frozen lumps, roots, sod, and other deleterious material. Ensure that material conforms to the following:

- (a) Gradation, uniform coarse to fine .....Table 704-2
- (b) Liquid limit, AASHTO T 89 .....30 max.

Table 704-2. - Select topping gradation.	
Sieve Size (inch)	Percent by Weight Passing Designated Sieve (AASHTO T 27 and T 11)
3	100
No. 200	0-15

**704.09 Bed Course**

Furnish porous, free-draining granular material free of excess moisture, muck, frozen lumps, roots, sod, and other deleterious material. Ensure that material conforms to the following:

- (a) Gradation, uniform coarse to fine .....Table 704-3
- (b) Liquid limit, AASHTO T 89 .....30 max.

Table 704-3. - Bed course gradation.	
Sieve Size	Percent by Weight Passing Designated Sieve (AASHTO T 27 and T 11)
1/2	100
No. 200	0-10

**704.10 Select Granular Backfill**

Furnish sound, durable granular material free from organic matter or other deleterious material (such as shale or other soft particles with poor durability). Ensure that material conforms to the specifications below.

**(a) Quality Requirements.** Furnish material that meets the following quality requirements:

- (1) Gradation .....Table 704-4
- (2) Shear angle of internal friction, AASHTO T 236<sup>1</sup> .....34° min.
- (3) Sodium sulfate soundness loss (five cycles), .....AASHTO T 104  
15% max.
- (4) Los Angeles abrasion, AASHTO T 96 .....50% max.
- (5) Liquid limit, AASHTO T 89 .....30 max.

<sup>1</sup>Compact samples for AASHTO T 236 to 95 percent of the maximum density determined in accordance with AASHTO T 99, method C or D, and corrected for oversized material as set forth in AASHTO T 99.

**(b) Electrochemical Requirements.** Furnish material that meets the following electrochemical requirements:

- (1) Resistivity, AASHTO T 288, any method .....3,000  $\Omega$  x centimeter min.
- (2) pH, AASHTO T 289, any method .....5.0 to 10.0
- (3) Sulfate content, AASHTO T 290, any method<sup>1</sup> .....1,000 ppm max.
- (4) Chloride content, AASHTO T 291, any method<sup>1</sup> .....200 ppm max.

<sup>1</sup>Tests for sulfate and chloride content are not required when pH is between 6.0 and 8.0 and the resistivity is greater than 5,000  $\Omega$  x centimeter.

Table 704-4. - Select granular backfill gradation.	
Sieve Size (inch)	Percent by Weight Passing Designated Sieve (AASHTO T 27 and T 11)
4	100
3	75-100
No. 200	0-15

**704.11 Special Grout Backfill**

Furnish lean grout slurry composed of three parts Portland cement and eight parts fine aggregate by volume. Fly ash may be substituted for two of the three parts Portland cement. Ensure that material conforms to the following:

- (a) Water/cement ratio .....1.5
- (b) Portland cement .....701.01
- (c) Fly ash .....725.04, Type C
- (d) Fine aggregate .....703.01
- (e) Water .....725.01

**704.12 Crib Wall Backfill**

Furnish material in accordance with Subsection 704.10, but conform to the following:

- (a) Gradation .....Table 704-5
- (b) Unit weight .....3,200 lb/yd<sup>3</sup> min.

Table 704-5. - Crib wall backfill gradation.

<b>Sieve Size (inch)</b>	<b>Percent by Weight Passing Designated Sieve (AASHTO T 27 and T 11)</b>
3	100
No. 4	25-70
No. 50	5- 20
No. 200	0-5

**Section 705 - Rock**

**705.01 Gabion Rock**

Furnish hard, durable rock that is resistant to weathering and reasonably free of organic and spoil material. Ensure that rock conforms to the following specifications:

- (a) Coarse durability index, AASHTO T 210 .....52 min.
- (b) Unit weight of a filled basket .....100 lb/ft<sup>3</sup> min.
- (c) Gradation:
  - (1) Baskets 1 foot or greater in the vertical dimension:
    - (a) Max. dimension .....8 inches
    - (b) Min. dimension .....4 inches
  - (2) Baskets less than 1 foot in the vertical dimension:
    - (a) Max. dimension .....6 inches
    - (b) Min. dimension .....3 inches

**705.02 Riprap Rock**

Furnish hard, durable, angular rock free of organic and spoil material and resistant to weathering and water action. Do not use rounded rock, boulders, shale, or rock with shale seams. Furnish rock that conforms to the following:

- (a) Apparent specific gravity, AASHTO T 85 .....2.50 min.
- (b) Absorption, AASHTO T 85 .....4.2% max.
- (c) Coarse durability index, AASHTO T 210 .....52 min.
- (d) Gradation for the Class specified .....Table 705-1

**705.03 Rock for Masonry Structures**

Furnish sound, durable rock that is native to the vicinity of the work or is similar in texture and color to the native rock and has been proven satisfactory for the intended use.

Furnish dimensioned masonry rock free of reeds, rifts, seams, laminations, and minerals that may cause discoloration or deterioration from weathering.

Table 705-1. - Gradation requirements for riprap.			
Class	Percent of Rock by Weight	Weight (lbs)	Approximate Cubic Dimension <sup>b,c</sup> (inches)
1	20	22 to 33	6 to 8
	30	11 to 22	5 to 6
	40	1 to 11	2 to 5
	10 <sup>a</sup>	0 to 1	0 to 2
2	20	55 to 110	8 to 10
	30	22 to 55	6 to 8
	40	2 to 22	3 to 6
	10 <sup>a</sup>	0 to 2	0 to 3
3	20	220 to 330	14 to 16
	30	110 to 220	10 to 14
	40	11 to 110	5 to 10
	10 <sup>a</sup>	0 to 11	0 to 5
4	20	550 to 770	18 to 20
	30	220 to 550	14 to 18
	40	22 to 220	6 to 14
	10 <sup>a</sup>	0 to 22	0 to 6
5	20	1540 to 2200	26 to 28
	30	770 to 1540	20 to 26
	40	55 to 770	8 to 20
	10 <sup>a</sup>	0 to 55	0 to 8
6	20	1870 to 3530	28 to 33
	30	1100 to 1870	22 to 28
	40	110 to 1100	10 to 22
	10 <sup>a</sup>	0 to 110	0 to 10

<sup>a</sup> Furnish spalls and rock fragments graded to provide a stable compact mass.  
<sup>b</sup> The volume of a rock with these cubic dimensions will have a mass approximately equal to the specified rock weight.  
<sup>c</sup> Furnish stone with breadth and thickness at least one-third its length.

**(a) Sizes & Shapes.** Do not use rock with depressions or projections that might weaken it or prevent it from being properly bedded.

When no dimensions are shown on the plans, furnish the rocks in the sizes and with the face areas necessary to produce the general characteristics and appearance indicated on the plans.

Unless otherwise specified, furnish rock fragments with the following minimum dimensions:

- (1) Min. thickness .....5 inches
- (2) Min. width .....12 inches or  
1-1/2 times the  
thickness,  
whichever is greater

(3) Min. length .....1-1/2 times the width

When headers are required, furnish headers with lengths no less than the width of bed of the widest adjacent stretcher plus 12 inches.

Ensure that at least 50 percent of the total volume of masonry consists of rock with a volume of at least 0.04 yd<sup>3</sup>.

**(b) Dressing.** Dress the rocks to remove any thin or weak portions. Dress face rocks to provide bed and joint lines with a maximum variation from true line as follows:

(1) Cement rubble masonry .....1 ½ inches

(2) Class B masonry .....¾ inch

(3) Class A masonry .....¼ inch

(4) Dimensioned masonry .....Reasonably true

**(c) Bed Surfaces.** Bed surfaces of face rock normal to the faces of the rocks for 3 inches. Beyond that point, do not permit the departure from normal to exceed 1 inch in 12 inches for dimensioned masonry, and 2 inches in 12 inches for all other classes.

**(d) Joint Surfaces.** For dimensioned masonry, dress face rock joint surfaces normal to the bed surface. In all classes of masonry except dimensioned masonry, ensure that the joint surfaces of face rocks form an angle with the bed surfaces of not less than 45°.

Dress face rock joint surfaces normal to the bed surfaces and to the exposed faces of the rock for at least 2 inches. Beyond that point, do not permit the departure from normal to exceed 1 inch in 12 inches.

Do not round corners at the meeting of the bed and joint lines in excess of the following radii:

(1) Cement rubble masonry .....1 ½ inches

(2) Class B masonry .....1 inch

(3) Class A masonry .....No rounding

4) Dimensioned masonry .....No rounding

**(e) Arch Ring Rock Joint Surfaces.** Dress ring rock joint surfaces radial to the arch or normal to the front face to a depth of 3 inches. Beyond that point, the departure from the radial or normal may not exceed ¾ inch in 12 inches.

Dress the back surface adjacent to the arch barrel concrete parallel to the front face and normal to the intrados to a depth of 6 inches. When concrete is placed after the masonry is constructed, vary adjacent ring stones at least 6 inches in depth.

**(f) Finish for Exposed Faces.** Remove all drill or quarry marks from exposed faces. Pitch face stones to the line along all beds and joints. Finish the exposed faces as SHOWN ON THE DRAWINGS. The following symbols are used to represent the type of surface or dressing specified:

**(1) Fine Pointed (F.P.).** The point depressions are approximately 3/8 inch apart with surface variations not to exceed 1/8 inch from the pitch line.

**(2) Medium Pointed (M.P.).** The point depressions are approximately 5/8 inch with surface variations not to exceed 3/16 inch from the pitch line.

**(3) Coarse Pointed (C.P.).** The point depressions are approximately 1-3/16 inches apart with surface variations not to exceed 3/8 inch from the pitch line.

**(4) Split or Seam Faced (S.).** The surface presents a smooth appearance that is free from tool marks, with no depressions below the pitch line, and no projection exceeding 3/4 inch beyond the pitch line.

**(5) Rock Faced (R.F.).** The face is an irregular projecting surface without indications of tool marks, with no concave surfaces below the pitch line, and with projections beyond the pitch line. Do not permit the projections to exceed the maximum specified.

For example, where "1.5 R.F." is specified, do not permit projections beyond the pitch line to exceed 1½ inches. Where a "variable rock face" is specified, uniformly distribute stones of the same height of projection.

**705.04 Rock for Mechanically Placed Embankments**

Furnish hard, durable rock that is angular in shape, resistant to weathering, and graded in a well-balanced range of sizes. Furnish material that conforms to Table 705-2.

Table 705-2. - Gradation for mechanically placed rock.		
Percent of Rock Fragments by Weight	Weight (pounds)	Equivalent Cubic Dimension (inches)
50	>2000	> 28
50	90 - 2000	10 - 28

Rock placed below the high water mark of live streams shall have breadth and thickness at least one-third its length and conform to the following:

(a) Apparent specific gravity, AASHTO T 85 .....2.50 min.

(b) Absorption, AASHTO T 85 .....4.2% max.

(c) Coarse durability index, AASHTO T 210 .....52 min.

**705.05 Rock for Hand-Placed Embankments**

Furnish hard, durable rock that is angular in shape, resistant to weathering, and graded in a well-balanced range of sizes. Furnish material that conforms to Table 705-3.

Table 705-3. - Gradation for hand-placed rock.		
Percent of Rock Fragments by Weight	Weight (pounds)	Equivalent Cubic Dimension (inches)
75	>165	> 12
25	90 - 165	10 - 12

Rock placed below the high water mark of live streams shall have breadth and thickness at least one-third its length and conform to the following:

- (a) Apparent specific gravity, AASHTO T 85 .....2.50 min.
- (b) Absorption, AASHTO T 85 .....4.2% max.
- (c) Coarse durability index, AASHTO T 210 .....52 min.

**705.06 Stone Curbing**

**(a) Stone Curb, Type I.** Ensure that stone conforms to the size and shape specified, and to the following:

- (1) Furnish quarried limestone, sandstone, or granite from an approved source. Use one type of stone throughout the project. Do not use stone with visible drill marks on the exposed faces.
- (2) Saw or point the top surface of all vertical stone curb to an approximate true plane with no depression or projection on the top surface of more than ¼ inch. Pitch the front and back arris lines straight and true. Do not permit any projection or depression on the back surface to exceed a batter of 1 inch horizontal to 3 inches vertical.
- (3) Saw, point, or smooth quarry split the front exposed face of the vertical stone curb and form to an approximately true plane. Do not permit the remaining face distance to have any projections or depressions greater than 1 inch from the plane of the exposed face.
- (4) Square the ends of vertical stone curb with the top back and face and finish so that when the sections are placed end to end, no space more than ½ inch shows in the joint for the full width of the top surface and for the entire exposed front face. Do not permit the remainder of the end to break back more than 4 inches from the plane of the joint. Cut the joints of circular or curved stone curb on radial lines.

- (5) Ensure that the minimum length of any segment of vertical stone curb is 4 feet, except where a depressed or modified section of curb is required for driveways, crossings, closures, and so forth, where the length may vary.

**(b) Stone Curb, Type II.** Ensure that slope stone curb conforms to the requirements for Type I stone curb, except as follows:

- (1) On a horizontal top surface, limit the maximum allowable projection or depression to  $\frac{1}{2}$  inch. On other exposed faces, limit the maximum allowable projection or depression to 1 inch.
- (2) For unexposed surfaces, limit the maximum allowable projection or depression from a true plane on a 2-foot length to 3 inches.
- (3) On exposed faces between adjacent segments of slope stone curb, limit the maximum allowable space that shows to  $\frac{3}{4}$  inch. Ensure that the minimum length of any segment of slope stone curb is 2 feet.

## **Section 706 - Concrete & Plastic Pipe**

### **706.01 Nonreinforced Concrete Pipe**

Furnish pipe that conforms to AASHTO M 86 for the diameters and strength classes specified.

### **706.02 Reinforced Concrete Pipe**

Furnish pipe that conforms to AASHTO M 170 for the diameters and strength classes specified. Ensure that precast reinforced concrete end sections conform to the cited specifications, to the extent to which they apply.

### **706.03 Perforated Concrete Pipe**

Furnish pipe that conforms to AASHTO M 175, Type 1 or Type 2, and to AASHTO M 86 for the diameters and strength classes specified.

### **706.04 Reinforced Arch-Shaped Concrete Pipe**

Furnish pipe that conforms to AASHTO M 206 for the diameters and strength classes specified.

### **706.05 Reinforced Elliptical-Shaped Concrete Pipe**

Furnish pipe that conforms to AASHTO M 207 for the diameters, placement design (horizontal or vertical), and strength classes specified.

### **706.06 Reinforced D-Load Concrete Pipe**

Furnish pipe that conforms to AASHTO M 242 for the diameters specified.

### **706.07 Precast Reinforced Concrete Box Sections**

Furnish sections that conform to AASHTO M 259 or M 273, as applicable, for the dimensions and loading conditions specified.

### **706.08 Plastic Pipe**

Furnish perforated and nonperforated plastic pipe that conforms as shown below for the sizes and types SHOWN ON THE DRAWINGS. Ensure that joints specified as watertight conform to ASTM D 3212.

**(a) Smooth Wall Polyethylene Pipe.** Furnish 12- to 42-inch-diameter pipe conforming to ASTM F 714 and minimum cell Class, ASTM D 3350, 335434C.

**(b) Corrugated Polyethylene Pipe.** Furnish 12- to 36-inch-diameter pipe conforming to AASHTO M 294 and minimum cell Class, ASTM D 3350, 315412C or 324420C.

**(c) Profile Wall (Ribbed) Polyethylene Pipe.** Furnish 18- to 48-inch-diameter pipe conforming to ASTM F 894 and minimum cell Class, ASTM D 3350, 334433C or 335434C.

**(d) Corrugated Polyethylene Drainage Tubing.** Furnish 3- to 10-inch-diameter tubing conforming to AASHTO M 252.

**(e) Smooth Wall PVC Pipe.** Furnish 4- to 15-inch-diameter pipe conforming to AASHTO M 278 and minimum cell Class, ASTM D 1784, 12454C or 12364C. For sanitary sewer conditions, conform to ASTM D 3034.

**(f) Profile Wall (Ribbed) PVC Pipe.** Furnish 4- to 48-inch-diameter pipe conforming to AASHTO M 304M and minimum cell Class, ASTM D 1784, 12454C or 12364C. For sanitary sewer conditions, conform to ASTM F 794 or F 949.

**(g) ABS Pipe.** Furnish pipe conforming to AASHTO M 264. When perforated pipe is specified, ensure that perforations conform to AASHTO M 278.

## **Section 707 - Metal Pipe**

### **707.01 Ductile Iron Culvert Pipe**

Furnish pipe that conforms to ASTM A 716 for the sizes specified.

### **707.02 Metallic-Coated Corrugated Steel Pipe**

Furnish pipe, special sections (such as elbows, branch connections, and prefabricated flared end sections), and coupling bands that conform to AASHTO M 36 and AASHTO M 218, M 274, or M 289 for the dimensions and thicknesses specified.

Fabricate underdrain pipe from a minimum of 0.052-inch steel sheets. Use any class of perforation specified in AASHTO M 36.

### **707.03 Aluminum-Alloy Corrugated Pipe**

Furnish pipe, special sections (such as elbows, branch connections, and prefabricated flared end sections), and coupling bands that conform to AASHTO M 196 for the sectional dimensions and thicknesses specified.

Fabricate underdrain pipe from a minimum of 0.048-inch aluminum sheets. Use any class of perforation.

### **707.04 Asphalt-Coated Pipe**

Furnish pipe, special sections (such as elbows, branch connections, and prefabricated flared end sections), and coupling bands that conform to Subsections 707.02, 707.03, 707.08, 707.09, and 707.13, as applicable for the kinds of pipes to be coated. Coat the pipe with bituminous material conforming to AASHTO M 190 for the type of coating specified.

Coat special sections (such as elbows, branch connections, and end sections) and coupling bands in accordance with AASHTO M 190. Coat flared end sections with a Type A bituminous coating conforming to AASHTO M 190, or with a field-applied asphalt mastic coating conforming to AASHTO M 243.

### **707.05 Steel Structural-Plate Structures**

Furnish structures and assembly fasteners for connecting plates that conform to AASHTO M 167 for the sizes and types specified.

### **707.06 Aluminum-Alloy Structural-Plate Structures**

Furnish structures and assembly fasteners for connecting plates that conform to AASHTO M 219 for the sizes and types specified.

### **707.07 Asphalt-Coated Structural-Plate Structures**

Furnish structures that conform to either Subsection 707.05 or Subsection 707.06, as applicable. Apply a bituminous coating at the place of fabrication conforming to AASHTO M 190 for a Type A coating, or apply an onsite asphalt mastic coating conforming to AASHTO M 243, as specified.

If asphalt coating is applied to the plates before field erection, identify each plate's nominal metal thickness by appropriately painting the data on the inside surface of the plate after coating. Other methods of plate identification may be used if approved.

#### **707.08 Polymer-Coated Steel Pipe**

Furnish pipe, special sections (such as elbows and branch connections), and coupling bands that conform to AASHTO M 245 and M 246. Furnish the pipe with a 250/250-polymer coating.

#### **707.09 Fiber-Bonded Bituminous-Coated Steel Pipe**

Furnish pipe, special sections (such as elbows, branch connections and prefabricated flared end sections), and coupling bands that conform to Subsection 707.02, but use a zinc metallic coating impregnated with an aramid fiber composite conforming to ASTM A 885.

After fabrication, coat the pipe sections with an asphalt material in accordance with AASHTO M 190 for the type of coating specified.

Coat coupling bands with a bituminous material in accordance with AASHTO M 190, Type A. Coupling bands do not require fiber bonding.

#### **707.10 Slotted Drain Pipe**

Furnish pipe that conforms to AASHTO M 36 and AASHTO M 218, M 274, or M 289 for the dimensions and thicknesses specified. Fabricate the pipe with either angle or grate slots and as detailed on the plans.

Ensure that slot angles for the angle slot drain conform to ASTM A 36, and that grate assemblies for the grate slot drain conform to ASTM A 570. Galvanize slot angles and grate slot assemblies in accordance with Subsection 725.12.

#### **707.11 Metallic-Coated Spiral Rib Pipe**

Furnish pipe, special sections (such as elbows and branch connections), and coupling bands that conform to AASHTO M 36, Type IR and IIR, and AASHTO M 218, M 274, or M 289 for the dimensions and thicknesses specified.

### **707.12 Aluminum-Alloy Spiral Rib Pipe**

Furnish pipe, special sections (such as elbows and branch connections), and coupling bands that conform to AASHTO M 196, Type IR and IIR, for the dimensions and thicknesses specified.

### **707.13 Concrete-Lined Corrugated Steel Pipe**

Furnish pipe, special sections (such as elbows and branch connections), and coupling bands that conform to Subsection 707.02 for the dimensions and thicknesses specified.

Fully line the pipe and special sections with concrete, in accordance with ASTM A 849, Class C.

### **707.14 Invert-Paved Corrugated Steel Pipe**

Furnish pipe, special sections (such as elbows and branch connections), and coupling bands that conform to Subsection 707.02 for the dimensions and thicknesses specified.

Pave the invert of the pipe and special sections with concrete or asphalt material, in accordance with ASTM A 849, Class C or B, as specified.

### **707.15 Repair of Damaged Coatings**

Repair damaged coatings in accordance with AASHTO M 36 and ASTM A 849.

**Section 708 - Paint**

**708.01 Paint, General**

Furnish a contrasting color for each coat of paint. For the finish coat color, conform to FSS 595 B. If requested by the CO, provide color chips from the paint supplier.

**(a) Packaging.** Furnish paint in strong, substantial containers plainly marked with the following:

- (1) Trade name or trademark.
- (2) Paint type, color, formulation, lot number, and date of manufacture.
- (3) Net weight.
- (4) Volume, including the percent of solids and the percent of volatile organic compound (VOC).
- (5) Storage requirements.
- (6) Mixing and equipment cleanup instructions.
- (7) Name and address of the manufacturer.

**(b) VOC Content.** Conform to the following VOC limits for both shop and field paintings:

- (1) Clear (unpigmented) .....4.3-lbs/Gal max.
- (2) Other coatings .....2.9-lbs/Gal max.

**(c) Lead Content.** Furnish paint with a maximum lead content of 0.06 percent by weight in the dried film.

**(d) Other Properties.** Furnish paint that:

- (1) Does not show excessive settling in a freshly opened full can.
- (2) Easily redisperses with a paddle to a smooth, homogeneous state free of curdling, livering, caking, color separation, lumps, and skins.
- (3) Does not skin within 48 hours in a closed container that is three-fourths full.
- (4) Brushes on easily.
- (5) Possesses good leveling properties.

- (6) Shows no running or sagging tendencies when applied to smooth steel vertical surfaces.
- (7) Dries to a smooth uniform finish, free from roughness, grit, unevenness, and other surface imperfections.
- (8) Shows no streaking or separation when flowed on clean glass.
- (9) Shows no thickening, curdling, gelling, or hard caking after 6 months storage in a full, tightly covered container at a temperature of 70 °F.

**708.02 Paint for Timber Structures**

- (a) **Primer.** Conform to FSS TT-P-25, TT-P-96D, or TT-P-001984.
- (b) **Paint.** Conform to FSS TT-P-102, Class A; TT-P-96D; TT-P-102F; or TT-P-19D.

**708.03 Paint for Concrete & Masonry Block Structures**

Conform to FS TT-P-19. Color tint with universal or all-purpose concentrates.

**708.04 Paint for Steel Structures**

- (a) **Inorganic Zinc Primer.** Conform to AASHTO M 300, Type II.
- (b) **Vinyl Wash Primer.** Conform to MIL-P-15328 or SSPC number 27.
- (c) **Aliphatic Urethane Coating.** Conform to U.S. Product Standard C-644, Type I.
- (d) **Acrylic Latex Coating.** Conform to SSPC number 24.

**708.05 Penetrating Stain**

Conform to the following:

- (a) Weatherometer on base material, ASTM G 23 .....1,000 hours
- (b) Acrylic dispersion .....73.4% of nonvolatile vehicle
- (c) Viscosity .....58 ± 2 Krebs units
- (d) Solids volatile content .....40.3%

Store stain in accordance with the manufacturer’s recommendations.

## **Section 709 - Reinforcing Steel & Wire Rope**

### **709.01 Reinforcing Steel**

**(a) General.** Furnish the following information with each shipment of steel to the project:

- (1) Name and location of the steel rolling mill.
- (2) Manufacturing process.
- (3) Heat number(s).
- (4) Size(s).
- (5) Specifications.
- (6) Copies of mill test analyses for chemical and physical tests.
- (7) Consignee and destination of shipment.

**(b) Reinforcing Bars.** Furnish deformed, Grade 60 bars conforming to AASHTO M 31, M 42, or M 53.

**(c) Epoxy-Coated Reinforcing Bars.** Conform to AASHTO M 284.

Inspect the reinforcing bars after the near white blast cleaning. Reject all bars with steel slivers or scabs. Selective sorting and rejection at the fabricator's shop may avoid unnecessary delays and subsequent rejection of bars during the precoating inspection at the coating applicator's shop.

Coat epoxy-coated reinforcing steel in a plant certified by CRSI as a fusion-bonded epoxy applicator.

**(d) Tie Bar.** Furnish deformed, Grade 60 bars conforming to AASHTO M 31 or M 42, except do not use AASHTO M 42 steel for tie bars bent and restraightened during construction.

**(e) Hook Bolts.** Furnish plain, Grade 60 bars conforming to AASHTO M 31 or M 42 with M14 rolled threads or M16 cut threads. Furnish a threaded sleeve nut capable of sustaining a minimum axial load of 15,000 pounds.

**(f) Dowel Bars.** Conform to AASHTO M 254, Type A or B. Use plain round bars, free from burring or other deformation restricting free movement in the concrete. Paint half the length of each dowel bar with one coat of tar paint. When the paint dries and immediately before placing the dowels, lubricate the painted end to prevent concrete from bonding to the painted end.

For expansion joints, furnish a dowel cap that snugly covers 2 inches  $\pm$  ¼ inch of the dowel, has a closed end, and has a suitable stop to hold the closed end 1 inch from the end of the dowel bar.

Lubricants for Type B dowels may be rapid-curing cutback asphalt, medium-setting emulsified asphalt, or a flaked graphite and vehicle. Lubricants are not required for Type A coated dowel bars.

Furnish dowel assemblies that hold dowel bars within ¼ inch tolerance vertically and horizontally during concrete placement and permit unrestricted movement of the pavement slab.

Use wire conforming to AASHTO M 32 for dowel assemblies. Coat dowel assemblies with the same material as the dowel bar. Recoat or repair damaged coatings equivalent to the manufacturer's original coating.

**(g) Deformed Steel Wire.** Conform to AASHTO M 225.

**(h) Welded Steel Wire Fabric.** Conform to AASHTO M 55.

**(i) Cold-Drawn Steel Wire.** Conform to AASHTO M 32.

**(j) Welded Deformed Steel Wire Fabric.** Conform to AASHTO M 221.

**(k) Fabricated Deformed Steel Bar or Rod Mats.** Conform to AASHTO M 54.

**(l) Low-Alloy Steel Deformed Bars.** Conform to ASTM A 706.

#### **709.02 Wire Rope or Wire Cable**

Conform to AASHTO M 30 for size and strength class specified.

#### **709.03 Prestressing Steel**

Fabricate from one of the following:

(a) Stress-relieved wire strand, AASHTO M 204, Type BA or WA.

(b) Stress-relieved seven-wire strand, AASHTO M 203, Grade 270.

(c) High-strength steel bars, AASHTO M 275, Type II.

Protect all prestressing steel against physical damage, rust, or corrosion at all times. Do not use damaged prestressing steel.

Package prestressing steel to protect it from physical damage and corrosion during shipping and storage. Place a corrosion inhibitor in the package. Use a corrosion inhibitor

that will have no deleterious effect on the steel, concrete, or bond strength of steel to concrete. Immediately replace or restore damaged packaging.

Mark the shipping package with a statement that the package contains high-strength prestressing steel and a warning to use care in handling. Identify the type, kind, and amount of corrosion inhibitor used, including the date when placed, safety regulations, and instructions for use. For identification purposes, assign a lot number and tag to all wire, strand, anchorage assemblies, or bars shipped to the site.

Submit representative samples from members fabricated offsite. In the case of wire or strand, take the sample from the same master roll.

## **Section 710 - Fence & Guardrail**

### **710.01 Barbed Wire**

Furnish galvanized barbed wire of the coating class specified in conformance with AASHTO M 280, and aluminum-coated steel barbed wire that conforms to AASHTO M 305, Type I.

### **710.02 Woven Wire**

Furnish galvanized woven wire fence fabric that conforms to AASHTO M 279 for the design number, grade, and coating specified, and aluminum-coated woven wire fence fabric that conforms to ASTM A 584.

### **710.03 Chain Link Fence**

Furnish chain link fabric, posts, rails, ties, bands, bars, rods, and other fittings and hardware that conform to AASHTO M 181 for the kind of metal, coating, size of wire, and mesh specified.

Furnish coiled spring steel tension wire that is 3/16 inch, conforms to ASTM A 641, and has hard temper with a Class 3 galvanized coating or an aluminized coating with a minimum coating weight of 0.40 ounces per square foot of aluminum. Use the same coating on the coiled spring steel tension wire as used on the rest of the chain link fence.

### **710.04 Fence Posts**

**(a) Wood.** Furnish wood posts with the details and dimensions SHOWN ON THE DRAWINGS. Furnish wood posts of sound, seasoned wood, peeled and with ends cut as SHOWN ON THE DRAWINGS. Furnish posts that are straight and have all knots trimmed flush with the surface. Where treated posts are called for, provide the kind and type of treatment that meets the requirements SHOWN ON THE DRAWINGS. The requirements for peeling may be omitted for Red cedar posts or bracing.

**(b) Concrete.** Ensure that all dimension timber and lumber required for fences or gates is sound, straight, and reasonably free from knots, splits, shakes, and other defects. Furnish the species and grades SHOWN ON THE DRAWINGS, and dress and finish on four sides.

Furnish concrete posts made of concrete that meets the requirements specified in Subsection 602.03, method A or B. Furnish steel reinforcement, as SHOWN ON THE DRAWINGS, that meets the requirements specified in Section 709.

**(c) Steel.** Furnish steel posts for line-type fencing that are manufactured in accordance with AASTM A 702 and galvanized in accordance with AASHTO M 111 (ASTM A 123), but ensure that tubular steel posts are galvanized in accordance with ASTM A 120. Furnish fittings, hardware, and other appurtenances that are galvanized in accordance

with ASTM A 120 by current standard practice, and are of standard commercial grade. Furnish weathering steel posts that meet the requirements of AASHTO M 222.

**(d) Aluminum.** Furnish aluminum alloy posts that meet the requirements of AASHTO M 181.

**710.05 Fence Gates**

Furnish frame gates used with chain link fences that conform to the applicable requirements of AASHTO M 181 for the types and sizes specified. Ensure that the fabric in the gate conforms to fabric in the chain link fence.

Furnish frame and wire gates used with woven wire and barbed wire fences that conform to the dimensions and material SHOWN ON THE DRAWINGS.

**710.06 Metal Beam Rail**

**(a) Galvanized Steel Rail.** Furnish W-beam or thrie-beam rail elements fabricated from corrugated sheet steel that conform to AASHTO M 180 for the designated shape, class, type, and weight of coating specified.

**(b) Corrosion-Resistant Steel Rail.** Furnish W-beam and thrie-beam rail elements and associated weathering steel hardware that conform to the following:

- (1) Shapes and plates .....AASHTO M 222
- (2) Rail elements .....ASTM A 606, Type 4
- (3) Fasteners.....AASHTO M 164,  
Type 3

**710.07 Box Beam Rail**

Furnish steel box beam rail elements that conform to the applicable standards contained in the AASHTO–Associated General Contractors of America (AGC)–ARTBA “Guide to Standardized Highway Barrier Hardware,” 1995 edition.

**710.08 Steel-Backed Timber Rail**

Furnish timber that conforms to AASHTO M 168. Fabricate the 6-inch by 10-inch timber rail and the 4-inch by 9-inch blockouts from dry, well-seasoned, and dressed rough-sawn Douglas Fir, Southern Pine, or other species with a stress grade of at least 1,500 pounds/square inch.

Treat the timber rail and blockout elements with CCA, ACZA, or ACA preservative treatment conforming to AWPAC 14, but ensure that the minimum retention is 0.60 pounds/cubic foot.

Fabricate the steel backing elements from 3/8 inch structural steel conforming to AASHTO M 222. Furnish fastener hardware that conforms to ASTM A 325, Type 3.

### 710.09 Guardrail Posts

**(a) Box Beam Post.** Furnish guardrail posts for metal beam guardrail that conform to the applicable standards contained in the AASHTO–AGC–ARTBA “Guide to Standardized Highway Barrier Hardware,” 1995 edition.

**(b) Steel-Backed Timber Post.** Furnish 10-inch by 12-inch guardrail posts for steel-backed timber rail that conform to specifications in Subsection 710.08. Use the post lengths SHOWN ON THE DRAWINGS.

**(c) Wood Post.** Do not use a wooden guardrail post that has a through check, shake, or end split in the same plane as the bolt hole, or in a plane parallel to the bolt hole, and that extends from the top of the post to within 3 inches of the bolt hole.

### 710.10 Guardrail Hardware

Furnish guardrail hardware for use with galvanized steel beam rail that conforms to the standards contained in the AASHTO–AGC–ARTBA “Guide to Standardized Highway Barrier Hardware,” 1995 edition. Ensure that guardrail hardware for corrosion-resistant steel conforms to the requirements specified in Subsection 710.06.

Except for material covered in Subsection 710.06, make all angles, channels, wide flanges, and plates not contained in the above standard conform to ASTM A 36, but make the structural tubing for the short steel post conform to ASTM A 500 or A 513, Grade 1008. Galvanize soil plates and structural tubing in accordance with ASTM A 123. Do not punch, drill, cut, or weld the metal after galvanizing.

Manufacture reflector tabs from 1/8-inch aluminum or galvanized steel sheets. Use adhesive that resists peeling with a force of 5 pounds per inch of width. Use mildew resistant adhesive that has no staining effect on the reflective sheeting.

### 710.11 Temporary Plastic Fence

Furnish plastic noncorrosive fence fabricated from high-density polyethylene (HDPE) and ultraviolet-stabilized for outdoor weathering. Furnish material that conforms to the following:

- (a) Height .....48 inches min.
- (b) Mesh openings .....3 1/8 to 3 3/8 inches
- (c) Color .....International orange
- (d) Weight .....0.16-lb/ft min.

### **710.12 Crash Cushion Barrels**

Furnish 36-inch-diameter barrels made of HDPE structural foam or equal material. Furnish lids of the same material as the barrels, but of a thinner gauge. Furnish appropriate height cores made of polystyrene or equivalent material.

### **710.13 Timber Rails**

Furnish timber rail that is cut from dry, well-seasoned, and dressed timber stock that meets the requirements of AASHTO M 168 for the grade and species SHOWN ON THE DRAWINGS.

Provide preservative treatment that meets the requirements specified in Subsection 716.03, or as SHOWN ON THE DRAWINGS.

Furnish rustic rails that are straight, sound, and free of injurious defects, and are cut from live trees not less than 30 days, and not more than 1 year, before use. Ensure that they are stripped of bark before seasoning or stored under water. Immediately before the logs are used in the work, trim all knots and projections smooth and, if logs are water cured, peel all bark.

## Section 711 - Concrete Curing Material & Admixtures

### 711.01 Curing Material

Conform to the following:

- (a) Burlap cloth .....AASHTO M 182
- (b) Waterproof paper.....AASHTO M 171
- (c) Polyethylene film .....AASHTO M 171
- (d) Liquid membrane-forming compounds .....AASHTO M 148

### 711.02 Air-Entraining Admixtures

Conform to AASHTO M 154.

For structural concrete, furnish air-entraining admixtures classified as vinsol resin or neutralized vinsol resin.

### 711.03 Chemical Admixtures

Furnish water-reducing, set-retarding, and set-accelerating additives, or combinations thereof, that conform to AASHTO M 194. Do not combine chemical admixtures together in a mixture unless they are compatible. Furnish supporting documentation of compatibility from the manufacturers. Do not use chloride accelerators.

### 711.04 Latex Modifier

Furnish a homogeneous, nontoxic, film-forming polymeric emulsion with stabilizers added at the point of manufacture. Conform to the following:

- (a) Color .....White
- (b) Styrene butadiene polymer type .....68 ± 4% styrene 32  
± 4% butadiene
- (c) Chlorides .....0%
- (d) Polymer particle size .....1,500 to 2,500  
Angstroms avg.
- (e) Emulsion stabilizers .....Anionic and nonionic  
surfactant
- (f) Solids .....46.5 to 49.0%

(g) Weight .....8.4 to 8.55 lbs/Gal

(h) pH .....9 to 13

(i) Shelf life .....2 years min.

## Section 712 - Joint Material

### 712.01 Sealants, Fillers, Seals, & Sleeves

Conform to the following:

**(a) Joint Sealants & Crack Fillers.** Furnish a commercial certification identifying the batch and/or lot number, material, quantity of batch, date and time of manufacture, and name and address of the manufacturer. Conform to the following:

(1) Concrete joint sealer, hot-poured elastic type .....ASTM D 1190

(2) Joint sealants, hot-poured, for concrete and asphalt pavement .....ASTM D 3405

(3) Crack filler, hot-applied, for asphalt concrete and Portland cement concrete pavements .....ASTM D 5078

(4) For proprietary asphalt-rubber products, furnish the following:

(a) Source and grade of asphalt cement.

(b) Total granulated rubber content and mass, as a percent of the asphalt rubber mixture.

(c) Granulated rubber type(s) and content of each type (if blend).

(1) Mass as a percent of combined rubber.

(2) Gradation of granulated rubber.

(d) Type of asphalt modifier, if any.

(e) Quantity of asphalt modifier and mass as a percent of asphalt cement.

(f) Other additives.

(g) Heating and application temperatures.

(h) Manufacturer's recommended application procedures.

**(b) Preformed Expansion Joint Fillers.** Furnish in a single piece for the depth and width required for the joint:

(1) Preformed expansion joint filler for concrete (bituminous type) .....AASHTO M 33

- (2) Preformed sponge rubber expansion joint fillers for concrete paving and structural construction .....AASHTO M 153
- (3) Preformed cork expansion joint fillers for concrete paving and structural construction<sup>1</sup> .....AASHTO M 153
- (4) Preformed expansion joint fillers for concrete paving and structural construction (nonextruding and resilient bituminous types).....AASHTO M 213

<sup>1</sup> Do not use in concrete structures.

**(c) Preformed Joint Seals & Sleeves.** Furnish material in accordance with the following:

**(1) Paving Applications.** Furnish a polychloroprene elastomeric seal conforming to AASHTO M 220. Use a lubricant adhesive with a minimum solids content of 22 percent by weight, in accordance with ASTM D 2369, and a maximum peel strength of 1,500 psi, in accordance with ASTM D 903. Use within 9 months of manufacture.

**(2) Manhole, Inlet, & Drainage Applications.** Furnish a multisectional neoprene rubber and ethylene propylene dimonomer rubber seal with a minimum thickness of 1/16 inch. Before shipping, coat the rubber with a nonhardening butyl rubber sealant to produce a watertight seal when installed. Properties and values are shown in Table 712-1.

Table 712-1. - Preformed joint seals.				
Physical Properties	ASTM Test Method	EPDM	Neoprene	Butyl Mastic
Tensile, (psi)	D 412	1,500	1,700	-
Elongation (%)	D 412	440	230	280
Tear resistance, (pounds/inch)	D 624 (Die B)	230	115	-
Rebound, (% 5 min.)	C 972 (mod.)	-	-	11
Rebound, (% 2 h)	C 972 (mod.)	-	-	12

**(d) Foam Filler.** Furnish an expanded polystyrene filler having a compressive strength of not less than 10 pounds/square inch.

**(e) Cold-Poured Sealer.** Furnish a one-part, low-modulus silicone rubber-base joint-sealing compound conforming to FSS TT-S-1543, Class A, with an ultimate elongation of 1,200 percent.

**(f) Low-Modulus Silicone Joint Sealant.** Furnish a one-part silicone formulation conforming to the following:

- (1) Flow, MIL-S-8802 .....5/16 inch max.
- (2) Extrusion rate, MIL-S-8802 .....2.65 to 8.82 g/min



**712.04 Oakum**

Fabricate oakum from a thoroughly corded and finished hemp (*Cannabis sativa*) line, Benares Sunn fiber, or a combination thereof that is reasonably free from lumps, dirt, and extraneous matter.

**712.05 Mortar for Masonry Beds & Joints**

**(a) Composition.** Mix one part masonry cement, Portland cement, or air-entraining Portland cement with two parts fine aggregate by volume. Lime or fly ash may be added in an amount not to exceed 10 percent of the Portland cement by weight. In lieu of air-entraining cement, Portland cement may be used with an air-entraining admixture, in accordance with the applicable provisions of Subsections 552.06 and 552.08.

**(b) Material.** Conform to the following:

- (1) Masonry cement/Portland cement.....701.01
- (2) Fine aggregate .....703.01 or  
AASHTO M 45
- (3) Hydrated lime .....725.03
- (4) Fly ash .....725.04
- (5) Water .....725.01
- (6) Air-entraining admixtures .....711.02

**(c) Comprehensive Strength.** Use mortar with a minimum 28-day comprehensive strength of 2,000 psi when tested according to AASHTO T 22 and T 23, except that samples shall consist of cylinders with a length-to-diameter ratio of 2 to 1.

**712.06 Copper Water Stops or Flashings**

Furnish sheet copper for water stops or flashings that conform to AASHTO M 138, copper USN number C11000. The resistivity test is not required.

**712.07 Rubber Water Stops**

Furnish molded or extruded rubber with a uniform cross section that is free from porosity or other defects. If approved, an equivalent standard shape may be furnished.

Fabricate rubber water stops from a compound of natural rubber, synthetic rubber, or a blend of the two, together with other compatible material. Do not use any reclaimed material. Furnish a certification from the producer showing the composition of the material. Conform to the following:

- (a) Hardness (shore), 3021<sup>1</sup> .....60 to 70
- (b) Compression set, 3311<sup>1</sup> .....30% max.
- (c) Tensile strength, 4111<sup>1</sup> .....2,500 psi
- (d) Elongation at breaking, ASTM D 412 .....450% min.
- (e) Tensile stress, 300% elongation, 4131<sup>1</sup> .....900 psi
- (f) Water absorption by weight, 6631<sup>1</sup> .....5% max.
- (g) Tensile strength after aging, 7111<sup>1</sup> ..... 80% of original, min.

<sup>1</sup> Federal Test Method Standard number 601.

### 712.08 Plastic Water Stops

Fabricate from a homogeneous, elastomeric, plastic compound of basic PVC and other material. Form to a uniform cross section that is free from porosity and other defects. If approved, an equivalent standard shape may be furnished. Conform to the following:

- (a) Tensile strength, ASTM D 638 .....1,400 psi
- (b) Elongation at breaking, ASTM D 638 .....250% min.
- (c) Hardness, ASTM D 2240 .....60 to 75 shore
- (d) Specific gravity, 5011<sup>1</sup> .....Manufacturer's value  
± 0.02
- (e) Resistance to alkali,<sup>2</sup> ASTM D 543:
  - (1) Mass change .....– 0.10 to + 0.25%
  - (2) Hardness change .....± 5 shore max.
  - (3) Tensile strength change .....15% max.
- (f) Water absorption (48 hours), ASTM D 570 .....0.50% max.
- (g) Cold bending<sup>3</sup> .....No cracking
- (h) Volatile loss, ASTM D 1203 .....Not more than  
manufacturer's value

<sup>1</sup> Federal Test Method Standard number 406.

<sup>2</sup> Use a 10 percent solution of NaOH for a 7-day test period.

<sup>3</sup> Subject a 1 - X 6 -inch strip that is 1/8 inch thick to a temperature of -20 °F for a period of 2 hours. After the 2 hours, immediately bend the sample 180° around a 1/8-inch-diameter rod. Apply sufficient force to maintain contact with the rod during bending. Examine the sample for evidence of cracking. Test and report results for at least three individual samples from each lot.

Furnish the manufacturer's test results for the above properties with the product certification. If directed, furnish samples in lengths adequate for performing the specified tests.

**Section 713 - Roadside Improvement Material**

**713.01 Topsoil**

**(a) Furnished Topsoil.** Furnish fertile, friable, free-draining, sandy loam soil free of subsoil, refuse, stumps, roots, brush, weeds, rocks or stones larger than 1 inch, and other substances detrimental to the development of vegetative growth. Demonstrate that the soil will sustain healthy crops of grass, shrubs, or other plant growth. Furnish material that conforms to the following:

(1) Texture:

- (a) Organic matter, AASHTO T 267 .....3 to 10%
- (b) Sand, AASHTO T 88 .....20 to 70%
- (c) Silt, AASHTO T 88 .....10 to 60%
- (d) Clay, AASHTO T 88 .....5 to 30%

(2) pH, AASHTO T 289 .....6 to 8

**(b) Conserved Topsoil.** Conserve natural humus-bearing soils from the overlying portions of the roadway excavation and embankment areas, in accordance with Subsection 203.06(e).

**713.02 Agricultural Limestone**

Furnish calcic or dolomitic ground limestone conforming to the standards of the Association of Official Analytical Chemists International, applicable State and Federal regulations, and the following:

- (a) Purity (calcium and magnesium) carbonates .....75% min.
- (b) Gradation .....Table 713-1

Granulated slag or other approved natural sources of lime may be used, provided that the application rate is adjusted to equal the total neutralizing power of the specified ground limestone.

Table 713-1. - Agricultural limestone gradation.	
Sieve Size	Minimum % by Weight Passing Designated Sieve (AASHTO T 27)
No. 10	90
N0. 40	50

### **713.03 Fertilizer**

Furnish standard commercial-grade dry formulated fertilizer conforming to the standards of the Association of Official Analytical Chemists International, applicable State and Federal regulations, and required minimum percentages of available nutrients.

Supply the fertilizer in new, clean, sealed, and properly labeled containers with name, weight, and guaranteed analysis of contents clearly marked.

A liquid form of fertilizer containing the minimum percentage of available nutrients may be used.

### **713.04 Seed**

Furnish seed that conforms to FSS JJJ–S–181 for seed testing and quality, and is in conformance with the State Seed Acts. If seed species in the specified seed mix are not listed in FSS JJJ–S–181, furnish certified weed-free seed. Do not use wet, moldy, or otherwise contaminated or damaged seed.

Provide seeds as follows:

- (a) Furnish each seed type in a separate standard sealed container. Clearly label each container with the following:

- (1) Name and type of seed.
- (2) Lot number.
- (3) Net weight.
- (4) Percent of purity, germination, and hard seed.
- (5) Percent of maximum weed seed content.

Inoculate legume seed with approved cultures, in accordance with the manufacturer's instructions.

- (b) Furnish a product certification for each kind or type of seed, certifying that the seed was tested by a recognized laboratory within 6 months of the date of delivery. Include the following:

- (1) Name and address of testing laboratory.
- (2) Date of test.
- (3) Seed identification.
- (4) Test results showing the percentages of purity, germination, and weed content.

(5) Certified weed-free seed.

### **713.05 Mulch**

**(a) Straw.** Obtain straw for mulching from oats, wheat, rye, or other grain crops that are free from weeds, mold, and other objectionable material. Furnish straw mulch in an air-dry condition suitable for placing with mulch blower equipment.

**(b) Hay.** Obtain hay from herbaceous mowing. Ensure that it is free from weeds, mold, and other objectionable material. Furnish hay in an air-dry condition suitable for placing with mulch-blower equipment.

**(c) Wood Fiber.** Furnish processed wood fiber from wood chips that is:

- (1) Colored with a green dye noninjurious to plant growth.
- (2) Readily dispersible in water.
- (3) Nontoxic to seed or other plant material.
- (4) Free of growth or germination inhibiting substances.
- (5) Certified weed-free seed.
- (6) Air dried to an equilibrium moisture content of  $12 \pm 3$  percent.
- (7) Packaged in new, labeled containers.
- (8) Packaged in a condition appropriate for mixing in a homogeneous slurry suitable for application with power-spray equipment.

**(d) Grass Straw Cellulose Fiber.** Furnish processed grass straw fiber that is:

- (1) Colored with a green dye noninjurious to plant growth.
- (2) Readily dispersible in water.
- (3) Nontoxic to seed or other plant material.
- (4) Free of growth- or germination-inhibiting substances.
- (5) Certified weed-free seed.
- (6) Air dried to a moisture content of  $10 \pm 0.2$  percent.
- (7) Air dried to a uniform weight of  $\pm 5$  percent.

(8) Packaged in new containers labeled with the manufacturer's name and air dry weight.

(9) Packaged in a condition appropriate for mixing in a homogeneous slurry suitable for application with power-spray equipment

**(e) Sawdust.** Obtain sawdust from wood that has not been subjected to conditions that would cause the sawdust to lose its value or usefulness as mulch. Ensure that sawdust contains no toxic substances and has been naturally aged for at least 5 years.

**(f) Peat Moss.** Furnish a granulated sphagnum peat moss that is air dried, in conformance with State and Federal regulations, and meets the following requirements:

- (1) Sticks, stones, and mineral matter .....0%
- (2) Partially decomposed stems and leaves of sphagnum .....75% min.
- (3) Color .....Brown
- (4) Texture .....Porous fibrous  
to spongy fibrous
- (5) pH .....3.5 to 7.5

**(g) Mature Compost.** Furnish partially decomposed organic materials, such as leaves, grass, shrubs, and yard trimmings, cured for 4 to 8 weeks. Maturity is indicated by temperature stability and soil-like odor. Furnish friable, dark brown, weed- and pathogen-free mature compost with the following properties:

- (1) Carbon/nitrogen ratio .....25:1 to 35:1
- (2) Carbon/phosphorus ratio .....120:1 to 240:1
- (3) pH .....6.0 to 7.8
- (4) Water content .....40% max.
- (5) Particle size:
  - (a) Seeding and sodding .....½ inch max.
  - (b) Erosion control .....1 inch max.
- (6) Organic material .....50% min.
- (7) Manmade inserts (plastic, glass, and metal) .....2% max.

**(h) Straw for Hydroseeding.** Use clean agricultural straw. Mill fibers to 1 inch or less in length. Dry the fibers to 10 percent moisture for compaction. Bale in heat-sealed plastic bags.

**(i) Bonded Fiber Matrix Hydramulch.** Furnish a mixture of long wood fibers and bonding agent that, when hydraulically applied and dried, produces a matrix that:

- (1) Does not dissolve or disperse when wetted.
- (2) Holds at least 10 ounces of water per ounce of dry matrix.
- (3) Has no germination- or growth-inhibiting factors.
- (4) Forms no water-insensitive crust.
- (5) Contains materials that is 100 percent biodegradable

### **713.06 Plant Material**

Conform to “American Standard for Nursery Stock.”

**(a) Quality of Plant Material.** Furnish plants that are excellent representatives of their normal species or varieties. Ensure that all plants are nursery-grown stock that has been transplanted or root-trimmed two or more times, in accordance with the kind and size of plants. Furnish plants with a normal developed branch system that is free from disfiguring knots, sun-scald, injuries, abrasions of the bark, dead or dry wood, broken terminal growth, and other objectionable disfigurements.

Furnish trees that have reasonably straight stems and are well branched and symmetrical, in accordance with their natural habits of growth.

**(b) Plant Names.** For scientific and common plant names, conform to “Standardized Plant Names,” as adopted by the American Joint Committee on Horticultural Nomenclature. Legibly tag and identify all plants by name and size.

**(c) Grading Standards.** For grading of plants, conform to “American Standard for Nursery Stock,” as approved by ANSI.

**(d) Nursery Inspection and Plant Quarantine.** Furnish plants that are essentially free from plant diseases and insect pests.

Comply with all nursery inspection and plant quarantine regulations of the States of origin and destination, and with Federal regulations governing interstate movement of nursery stock. Provide a valid copy of the certificate of inspection with each package, box, bale, and carload shipped or otherwise delivered.

**(e) Balled & Burlapped Plants.** Obtain the plants from the original and undisturbed soil in which the plants were grown. Dig balled and burlapped plants to retain as many

fibrous roots as possible. Wrap, transport, and handle the plants so the soil ball and small and fibrous roots remain intact.

**713.07 Erosion Control Mats, Roving, & Geocell**

**(a) Erosion Control Mats.** Erosion control mats are designated as Types 1, 2, 3, 4, and 5, described below.

**(1) Type 1—Erosion Control Mats.** Type 1 mats are designated as follows:

*(a) Straw Erosion Control Mat.* Furnish a mat consisting of clean agricultural straw, in accordance with Subsection 713.05(a), that is attached to a photodegradable polypropylene netting by sewing with cotton thread. Ensure that material conforms to the specifications shown in Table 713-2.

Table 713-2. - Straw erosion control material.	
Material	Specification Minimums
Straw <sup>a</sup>	0.44 lb/yd <sup>2</sup>
Netting	Photodegradable netting on one side 0.20 – 0.80 inch square mesh <sup>b</sup> with a 3.0 lb/1000 ft <sup>2</sup> mass
<sup>a</sup> Moisture content shall not exceed 20 percent. <sup>b</sup> Dimensions are approximate and may vary to meet manufacturer’s standards.	

*(b) Burlap.* Furnish burlap fabric in a standard weave with a weight of 4.3 ± 0.7 ounces per square yard.

*(c) Jute Mesh.* Furnish jute mesh with a uniform open plain weave fabricated from jute yarn that does not vary in thickness by more than one-half its normal diameter, and that conforms to the following:

- (1) Mesh size ..... 1 x 1 inch max.
- (2) Mesh weight, ASTM D 1776 ..... 14-oz/yd<sup>2</sup> ± 5%

*(d) Woven Paper or Sisal Mesh Netting.* Furnish mesh netting of woven paper or woven sisal twisted yard conforming to the following:

- (1) Mesh openings ..... 1/8 to ¼ inch
- (2) Shrinkage after wetting ..... 20% max.

**(2) Type 2—Erosion Control Mats.** Type 2 mats are designated as follows:

(a) *Straw and Coconut Mat.* Furnish mat consisting of undyed, untreated, biodegradable, jute, coconut coir, synthetic polypropylene fibers, or other approved yarn woven into a plain weave mesh with 5/8- to 1-inch square openings. Ensure that material conforms to the specifications shown in Table 713-3.

Table 713-3. - Straw and coconut material.	
Material	Specification Minimums
Straw <sup>a</sup> 70%	0.44 lb/yd <sup>2</sup>
Coconut 30 %	0.44 lb/yd <sup>2</sup>
Netting	Photodegradable netting on one side. 5/8 – 1.0-inch square mesh <sup>b</sup> with a 3.0 lb/1,000 ft <sup>2</sup> mass
<sup>a</sup> . Moisture content shall not exceed 20 percent. <sup>b</sup> . Dimensions are approximate and may vary to meet manufacturer's standards.	

(b) *Excelsior Blanket.* Furnish a blanket of uniform thickness consisting of curled wood excelsior secured on the top side to biodegradable, photodegradable extruded plastic mesh. Make the blanket smolder resistant without the use of chemical additives. Conform to the following:

- (1) Excelsior fibers  $\geq$  8-inch length ..... 80% min.
- (2) Mesh size ..... 1 x 2 inch
- (3) Blanket mass/area ..... 15-oz/yd<sup>2</sup>  $\pm$  10%

(c) *Mulch Blanket.* Furnish a 1/8 inch to 1/2 inch blanket consisting of organic, biodegradable mulch such as straw, curled wood cellulose, coconut coir, or other material evenly distributed on one side of a photodegradable polypropylene mesh with a minimum weight of 8 ounces per square yard.

**(3) Type 3—Coconut Mats.** Furnish coconut mat consisting of undyed, untreated, biodegradable jute, coconut coir, synthetic polypropylene fibers, or other approved yarn woven into a plain weave mesh with approximately 5/8 inch to 1.0-inch square openings. Ensure that material conforms to the specifications shown in Table 713-4.

**(4) Type 4—Synthetic Erosion Control Mats and Meshes.** Type 4 erosion control mats are designated as follows:

(a) *Synthetic Erosion Control Mat.* Furnish a machine-produced flexible mat consisting of polyolefin monofilament fibers positioned between two biaxially oriented nets, and mechanically bound together by parallel stitching with polyolefin thread to form a three-dimensional weblike weave that is highly resistant to environmental and chemical deterioration. Ensure that material conforms to the specifications shown in Table 713-5.

Table 713-4. - Coconut erosion control mat.	
Material	Specification Minimum
Coconut <sup>a</sup>	0.44 lb/yd <sup>2</sup>
Netting	Photodegradable netting on one side. 5/8 to 1-inch square mesh <sup>b</sup> with a 3.0 lb/1000 ft <sup>2</sup> mass
<sup>a</sup> . Moisture content shall not exceed 20 percent. <sup>b</sup> . Dimensions are approximate and may vary to meet manufacturer's standards.	

Table 713-5. - Synthetic erosion control material.		
Property	Specification	Text Method
Color	Green	Visual
Thickness	¼ inch minimum	ASTM D 1777
Strength <sup>a</sup>	108 x 36 lbs/ft minimum	ASTM D 5035
Elongation <sup>a</sup>	50% maximum	ASTM D 5035
Porosity <sup>b</sup>	85% maximum	Calculated
Resiliency <sup>c</sup>	80%	ASTM D 1777
Ultraviolet stability <sup>d</sup>	80%	ASTM D 4355
<sup>a</sup> . Values for both machine and cross-machine directions under dry or saturated conditions. Machine direction specimen for 2-inch strip test includes one machine-direction polyolefin stitch line centered within its width and extending the full length of the specimen. <sup>b</sup> . Calculation based upon weight, thickness, and specific gravity. <sup>c</sup> . The percent of original thickness retained after three cycles of a 100-pounds per square inch load for 60 seconds, followed by 60 seconds without load. Thickness measured 30 minutes after load removed. <sup>d</sup> . Tensile strength retained after 1,000 hours in a Xenon ARC weatherometer.		

Table 713-6. - Synthetic polypropylene erosion control mesh.		
Property	Specification	Test Method
Color	Beige	Visual
Weight	1.74 oz/yd <sup>2</sup> minimum	ASTM D 5261
Tensile strength	460 x 250 lbs/ft	ASTM D 5035
Elongation at break	40% maximum	ASTM D 5035
Mullen burst strength	75 psi minimum	ASTM D 3786

(b) *Synthetic Polypropylene Mesh.* Furnish a flexible woven geotextile mesh fabricated from polypropylene fibers that have been spun in one direction. Ensure that material conforms to the specifications shown in Table 713-6.

(c) *Synthetic Mulch Control Netting.* Furnish a uniformly extruded, rectangular, plastic mesh netting with 2 x 2-inch nominal mesh openings and weighing at least 0.23 ounces per square yard.

(d) *Organic Mulch Control Netting.* Furnish a leno weave mesh netting fabricated from 28-pound biodegradable cellulose fiber yarn with five twists per 1 inch. Make the size of the mesh grid 1/2 to 1.0 inch square. Finish the selvedge to prevent raveling or fraying.

(5) *Type 5—Turf Reinforcement Mats.* Furnish a web of mechanically or melt bonded polymer netting, monofilaments, or fibers that are entangled to form a strong and dimensionally stable mat. Bonding methods include polymer welding, thermal or polymer fusion, and the placement of fibers between two high-strength, biaxially oriented nets mechanically bound together by parallel stitching with polyolefin thread. Ensure that the mat is resistant to biological, chemical, and ultraviolet degradation. Ensure that material conforms to the specifications shown in Table 713-7.

Table 713-7. - Synthetic polypropylene erosion control material.		
Property	Specification	Test Method
Color	Black	Visual
Thickness	1/2 inch minimum	ASTM D 1777
Tensile Strength <sup>a</sup>	94 x 54 lbs/ft minimum	ASTM D 5035
Elongation <sup>a</sup>	50% maximum	ASTM D 5035
Porosity <sup>b</sup>	90% minimum	Calculated
Resiliency <sup>c</sup>	80%	ASTM D 1777
Ultraviolet stability <sup>d</sup>	80%	ASTM D 4355

<sup>a</sup>. Values for both machine and cross-machine directions under dry or saturated conditions. Using 2" strip method.  
<sup>b</sup>. Calculation based upon weight, thickness, and specific gravity.  
<sup>c</sup>. The percent of original thickness retained after three cycles of a 100-pounds per square inch load for 60 seconds, followed by 60 seconds without load. Thickness measured 30 minutes after load removed.  
<sup>d</sup>. Tensile strength retained after 1,000 hours in a Xenon ARC weatherometer.

(b) **Roving.** Roving types are described below.

(1) *Fiberglass Roving.* Form fiberglass roving from continuous fibers drawn from molten glass, coated with a chrome-complex sizing compound, collected into strands and lightly bound together into roving without the use of clay, starch, or other similar deleterious substances. Wind the roving into a cylindrical package approximately 12 inches high so 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. Ensure that the material contains no petroleum solvents or other agents known to be toxic to plant or animal life, and that it conforms to the specifications shown in Table 713-8.

(2) *Polypropylene Roving.* Form polypropylene roving from continuous strands of fibrillated polypropylene yarn. Wind the roving into a cylindrical package so the roving can be continuously fed from the outside of the package through an ejector driven by compressed air, and can be expanded into a mat of polypropylene strands. Ensure that the material contains no agents that are toxic to plant or animal life, and that it conforms to the specifications shown in Table 713-9.

Table 713-8. - Fiberglass roving.		
Property	Specification	Test Method
Strands per rove	56 – 64	End count
Fibers per strands	184 – 234	End count
Fiber diameter (trade designation G)	0.0003 – 0.0005 inches	ASTM D 578
Yds/lb of rove	170-300	ASTM D 578
Yds/lb of strand	13,000 – 14,000	ASTM D 578
Organic content, % maximum	1.65	ASTM D 578

Table 713-9. - Polypropylene roving.		
Property	Specification	Test Method
Tensile strength	3.5 pound force	ASTM D 2256
Elongation of break	15.5%	ASTM D 2256
Weight of strand	360 denier	ASTM D 1907
Strands per rove	24	Measured
Ultraviolet stability	50% retained after 200 h	ASTM D 4335

**(c) Geocell (Cellular Confinement System).** Furnish a flexible honeycomb three dimensional structure fabricated from HDPE that has been ultraviolet-stabilized with carbon black and/or hindered anime light stabilizers.

#### 713.08 Miscellaneous Planting Material

**(a) Stakes for Bracing and Anchoring.** Fabricate stakes for bracing and anchoring trees from rough cypress, cedar, locust, or other approved wood that is essentially free from knots, rot, cross grain, and other defects that would impair the strength of the stake.

Ensure that stakes are a minimum 2 x 2 inch square in cross section, and of adequate length. Furnish stakes that conform to basic requirements of the American Lumber Standards Committee (ALSC).

Furnish anchor stakes that conform to the same size and quality as bracing stakes. The diameter and length of deadman will be SHOWN ON THE DRAWINGS.

**(b) Hose.** Furnish 1-inch-diameter garden or steam hose (rubber and fabric) to be used with wire for bracing and anchoring trees.

**(c) Wire.** Use 1/8-inch-diameter soft annealed galvanized steel wire for bracing and anchoring trees.

**(d) Wrapping Material.** Use 4-inch-wide rolls of waterproof paper (triple lamination 30–30–30) or 6-inch-wide rolls of burlap for wrapping trees.

**(e) Twine.** Use two-ply twine for trees 3 inches and less in diameter and three-ply twine for trees more than 3 inches in diameter for tying wrapping material to the trees.

**(f) Antidesiccant.** If approved, use a commercially available antidesiccant emulsion that will provide a film over plant surfaces permeable enough to permit transpiration.

**(g) Tree Wound Dressing.** Use commercially available products that have an asphalt base and contain a fungicide. Furnish a material that is antiseptic, waterproof, adhesive, and elastic. Do not use material that would be harmful to living tree tissue, such as kerosene, coal tar, creosote, and so forth.

### **713.09 Sprigs**

Furnish healthy living stems (stolons or rhizomes) and attached roots of the perennial turf-forming grasses as SHOWN ON THE DRAWINGS. Obtain sprigs from approved heavy and thickly matted sources in the locality of the work. Remove all Johnson grass and other objectionable grasses, weeds, and other detrimental material.

### **713.10 Sod**

Furnish living vigorous sod of the type of grass and thickness as SHOWN ON THE DRAWINGS. Furnish grass with a dense root system contained in suitable sod and reasonably free from noxious weeds and grasses. When the sod is cut, its top growth shall not be more than 3 inches in height.

### **713.11 Pegs for Sod**

Fabricate square or round pegs from sound wood. Ensure that pegs conform to the following:

- (a) Length .....8 inches min.
- (b) Approximate cross-sectional area .....1 square inch

### **713.12 Stabilizing Emulsion Tackifiers**

Furnish a commercially available product containing no solvents or other diluting agents toxic to plant life. Furnish material that conforms to one of the following:

- (a) Emulsified asphalt, grades SS-1, SS-1h, CSS-1, or CSS-1h.
- (b) Nonasphalt emulsions with a water-soluble natural vegetable gum, blended with gelling and hardening agents or a water-soluble blend of hydrophilic polymers, viscosifiers, sticking agents, and gums.
- (c) Polyvinyl acetate using emulsion resins and containing  $60 \pm 1$  percent total solids by weight.

### **713.13 Bales**

**(a) Straw Bales.** Tie the bales with either a commercial-quality baling wire or string. Ensure that straw and bales conform to the following:

- (1) Straw .....713.05(a)
- (2) Approximate length .....3 feet
- (3) Shape .....Rectangular
- (4) Approximate weight.....70 pounds

**(b) Wood Excelsior Bales.** Furnish bales of curled wood excelsior. Tie the bales with either commercial baling wire, plastic, or string. Ensure that bales conform to the following:

- (1) Approximate dimensions .....16 by 18 by 36 inches
- (2) Approximate weight.....70 pounds

#### **713.14 Sandbags**

Use clean, silt-free material for sand filler. Furnish material that conforms to the following:

- (a) Bag material .....Canvas or burlap
- (b) Volume per bag .....0.35 cubic foot min.

#### **713.15 Erosion Control Culvert Pipe**

Furnish culvert pipe fabricated from corrugated metal, plastic, or concrete for use in diverting live streams through work areas. Provide for AASHTO M 18 loading on temporary culvert pipe placed beneath the traveled way.

#### **713.16 Silt Fence**

Furnish silt fence consisting of a combination of the following materials, constructed as specified:

**(a) Posts.** Furnish 3-inch-diameter wood or 1.25 pounds per foot steel fence posts.

**(b) Supports.** Furnish 1/8-inch steel wire with a mesh spacing of 6 x 6 inch or a prefabricated polymeric mesh of equivalent strength.

**(c) Geotextile.** Furnish geotextile conforming to Subsection 714.01 and Table 714-5, as applicable.

**(d) Height.** Ensure that minimum height above the ground is 30 inches, and that minimum embedment depth is 6 inches.

If approved, variations from the above may be permitted to accommodate premanufactured fences.

## Section 714 - Geotextile, Geocomposite Drain Material, & Geogrids

### 714.01 Geotextiles

Use long-chain synthetic polymers composed by weight of at least 95 percent polyolefins or polyesters to manufacture geotextile or the threads used to sew geotextiles. Form the geotextiles, including selvages, into a stable network such that the filaments or yarns retain their dimensional stability relative to each other.

**(a) Physical Requirements.** For the specified type, see the following tables:

- (1) Subsurface drainage, Type I (A–F) .....Table 714-1
- (2) Separation, Type II (A–C) .....Table 714-2
- (3) Stabilization, Type III (A–B) .....Table 714-3
- (4) Permanent erosion control, Type IV (A–F) .....Table 714-4
- (5) Temporary silt fence, Type V (A–C) .....Table 714-5
- (6) Paving fabric, Type VI .....Table 714-6

All property values in these specifications, with the exception of apparent opening size (AOS), represent minimum average roll values in the weakest principal direction (i.e., ensure that average test results of any roll in a lot sampled for conformance or quality assurance testing shall meet or exceed the specified values). Values for AOS represent maximum average roll values.

Elevate and protect rolls with a waterproof cover if stored outdoors. When using a geotextile for a permanent installation, limit the geotextile exposure to ultraviolet radiation to less than 10 days.

**(b) Evaluation Procedures.** Furnish a product certification, including the name of the manufacturer, product name, and style number, chemical composition of the filaments or yarn, and other pertinent information to fully describe the geotextile.

When samples are required, remove a 3-foot-long full-width sample from beyond the first outer wrap of the roll. Label the sample with the lot and batch number, date of sampling, project number, item number, manufacturer name, and product name.

In addition, when geotextile joints are sewn, submit the seam assembly description and a sample of the sewn material. In the description, include the seam type, seam allowance, stitch type, sewing thread tex ticket number(s) and type(s), stitch density, and stitch gage. If the production seams are sewn in both the machine and crossmachine directions, provide sample-sewn seams that are oriented in both the machine and cross-machine directions. Furnish a sewn sample that has a minimum 6 feet of sewn seam and is at least 5 feet in width. Sew the sample seams with the same equipment and procedures that are

used to sew the production seams. Ensure that seams sewn onsite conform to the manufacturer's recommendations and are approved before installation.

Table 714-1. - Physical requirements for subsurface drainage geotextile.								
Property	Test Method ASTM	Units	Specifications <sup>a</sup>					
			Type I - A	Type I - B	Type I - C	Type I - D	Type I - E	Type I - F
Grab strength	D 4632	pounds	250/160	250/160	250/160	180/110	180/110	180/110
Sewn seam strength	D 4632	pounds	220/140	220/140	220/140	160/100	160/100	160/100
Tear strength	D 4533	pounds	90 <sup>c</sup> /55	90 <sup>c</sup> /55	90 <sup>c</sup> /55	67/40	67/40	67/40
Puncture strength	D 4833	pounds	90/55	90/55	90/55	67/40	67/40	67/40
Burst strength	D 3786	psi	390/190	390/190	390/190	300/140	300/140	300/140
Permittivity	D 4491	s <sup>-1</sup>	0.5	0.2	0.1	0.5	0.2	0.1
Apparent opening size	D 4751	inches	0.018 <sup>b</sup>	0.010 <sup>b</sup>	0.009 <sup>b</sup>	0.018 <sup>b</sup>	0.010 <sup>b</sup>	0.009 <sup>b</sup>
Ultraviolet stability	D 4355	%	50 <sup>d</sup>					

<sup>a</sup>. The first values in a column apply to geotextiles that break at < 50 percent elongation (ASTM D 4632). The second values in a column apply to geotextiles that break at ≥ 50 percent elongation (ASTM D 4632).

<sup>b</sup>. Maximum average roll value.

<sup>c</sup>. The minimum average roll tear strength for woven monofilament geotextile is 55 pounds.

<sup>d</sup>. After 500 hours of exposure.

## 714.02 Geocomposite Drains

Geocomposite drains consist of a polymeric drainage core with a geotextile conforming to Subsection 714.01(a)(1) attached to or encapsulating the core. Ensure that the geocomposite drain includes all necessary fittings and material to splice one sheet, panel, or roll to the next and to connect the geocomposite drain to the collector and outlet piping.

Fabricate the drainage core in sheet, panel, or roll form of adequate strength to resist installation stresses and long-term loading conditions. Furnish core material that consists of long chain synthetic polymers composed by weight of at least 85 percent polypropylene, polyester, polyamide, PVC, polyolefin, or polystyrene. Build the core up in thickness by means of columns, cones, nubs, cusps, meshes, stiff filaments or other configurations.

Ensure that geocomposite drains have a minimum compressive strength of 40 pounds per square inch when tested in accordance with ASTM D 1621, procedure A. Ensure that all splices, fittings, and connections have sufficient strength to maintain the integrity of the system during construction handling and permanent loading, and do not impede flow or damage the core.

Table 714-2. - Physical requirements for separation geotextile.

Property	Test Method ASTM	Units	Specifications <sup>a</sup>		
			Type II - A	Type II - B	Type II - C
Grab strength	D 4632	lbs.	315/200	250/160	180/110
Sewn seam strength	D 4632	lbs.	285/180	220/140	160/100
Tear strength	D 4533	lbs.	110/80	90 <sup>c</sup> /55	70/40
Puncture strength	D 4833	lbs.	110/80	90/55	70/40
Burst strength	D 3786	psi	500/250	400/190	300/140
Permittivity	D 4491	s <sup>-1</sup>	0.02	0.02	0.02
Apparent opening size	D 4751	in.	0.024 <sup>b</sup>	0.024 <sup>b</sup>	0.024 <sup>b</sup>
Ultraviolet stability	D 4355	%	50 <sup>d</sup>		

<sup>a</sup> The first values in a column apply to geotextiles that break at < 50 percent elongation (ASTM D 4632). The second values in a column apply to geotextiles that break at ≥50 percent elongation (ASTM D 4632).  
<sup>b</sup> Maximum average roll value.  
<sup>c</sup> The minimum average roll tear strength for woven monofilament geotextile is 55 pounds.  
<sup>d</sup> After 500 hours of exposure.

Table 714-3. - Physical requirements for stabilization geotextile.

Property	Test Method ASTM	Units	Specifications <sup>a</sup>	
			Type III-A	Type III-B
Grab strength	D 4632	lbs.	315/200	250/160
Sewn seam strength	D 4632	lbs.	285/180	220/140
Tear strength	D 4533	lbs.	110/80	90 <sup>c</sup> /55
Puncture strength	D 4833	lbs.	110/80	90/55
Burst strength	D 3786	psi	500/250	400/190
Permittivity	D 4491	s <sup>-1</sup>	0.05	0.05
Apparent opening size	D 4751	in.	0.017 <sup>b</sup>	0.017 <sup>b</sup>
Ultraviolet stability	D 4355	%	50 <sup>d</sup>	

<sup>a</sup> The first values in a column apply to geotextiles that break at < 50 percent elongation (ASTM D 4632). The second values in a column apply to geotextiles that break at ≥ 50 percent elongation (ASTM D 4632).  
<sup>b</sup> Maximum average roll value.  
<sup>c</sup> The minimum average roll tear strength for woven monofilament geotextile is 55 pounds.  
<sup>d</sup> After 500 hours of exposure.

Table 714-4. - Physical requirements for permanent erosion control geotextile.

Property	Test Method ASTM	Units	Specifications <sup>a</sup>					
			Type IV-A	Type IV-B	Type IV-C	Type IV-D	Type IV-E	Type IV-F
Grab strength	D 4632	pounds	315/200	135/200	315/200	250/160	250/160	250/160
Sewn seam strength	D 4632	pounds	285/180	285/180	285/180	220/140	220/140	220/140
Tear strength	D 4533	pounds	110/80	110/80	110/80	90 <sup>c/</sup> 55	90 <sup>c/</sup> 55	90 <sup>c/</sup> 55
Puncture strength	D 4833	pounds	110/80	110/80	110/80	90/55	90/55	90/55
Burst strength	D 3786	psi	500/250	500/250	500/250	400/190	400/190	400/190
Permittivity	D 4491	s <sup>-1</sup>	0.7	0.2	0.1	0.7	0.2	0.1
Apparent opening size	D 4751	inches	0.017 <sup>b</sup>	0.010 <sup>b</sup>	0.009 <sup>b</sup>	0.017 <sup>b</sup>	0.010 <sup>b</sup>	0.009 <sup>b</sup>
Ultraviolet stability	D 4355	%	50 <sup>d</sup>					

<sup>a</sup>. The first values in a column apply to geotextiles that break at < 50 percent elongation (ASTM D 4632). The second values in a column apply to geotextiles that break at ≥ 50 percent elongation (ASTM D 4632).

<sup>b</sup>. Maximum average roll value.

<sup>c</sup>. The minimum average roll tear strength for woven monofilament geotextile is 55 pounds.

<sup>d</sup>. After 500 hours of exposure.

Table 714-5. - Physical requirements for temporary silt fence.

Property	Test Method ASTM	Units	Specifications		
			Type V-A	Type V-B <sup>b</sup>	Type V-C <sup>c</sup>
Maximum Post Spacing		ft	4	4	6.5
Grab strength:					
Machine Direction	D 4632	lbs.	90	125	125
Cross Direction			90	100	100
Permittivity	D 4491	s <sup>-1</sup>	0.05	0.05	0.05
Apparent opening size	D 4751	inches	0.024 <sup>a</sup>	0.024 <sup>a</sup>	0.024 <sup>a</sup>
Ultraviolet stability	D 4355	%	70 <sup>d</sup>		

<sup>a</sup>. Maximum average roll value.

<sup>b</sup>. Elongation at break ≥ percent elongation (ASTM D 4632)

<sup>c</sup>. Elongation at break < percent elongation (ASTM D 4632)

<sup>d</sup>. After 500 hours of exposure.

Table 714-6. - Physical requirements for paving fabric.			
Property	Test Method	Specifications	
		Units	Type VI
Grab strength	ASTM D 4632	lbs.	110
Ultimate elongation	ASTM D 4632	lbs.	50% at break
Asphalt retention	Texas DOT item 3099	gal/ft <sup>2</sup>	0.022
Melting point	ASTM D 276	°F	300

Identify, ship, and store the geocomposite drains in accordance with AASHTO M 288. Elevate and protect sheets, panels, and rolls with a waterproof and ultraviolet-resistant cover if stored outdoors.

When using a geocomposite drain for a permanent installation, limit the geocomposite exposure to ultraviolet radiation to less than 10 days.

When samples are required, provide a 3-foot-square sample from products supplied as sheets or panels, or a 3-foot-length full-roll-width sample from products supplied in rolls. Label the sample with the lot and batch number, date of sampling, project number, item number, manufacturer's name, and product name.

**(a) Geocomposite Underdrains.** Ensure that the horizontal and vertical flow of water within the core interconnects at all times for the full height of the core; and\ water can pass from one side of the core to the other. Ensure that the drainage core with the geotextile in place provides a minimum flow rate of ½ gallon per minute per foot of width when tested in accordance with ASTM D 4716 under the following test conditions:

- (1) A specimen 12 inches long.
- (2) An applied load of 10 pounds per square inch.
- (3) A gradient of 0.1.
- (4) A 100-hour seating period.
- (5) A closed-cell foam rubber between platens and geocomposite.

Firmly attach the geotextile to the core so folding, wrinkling, and other movement cannot occur either during handling or after placement. Achieve bonding using nonwater-soluble adhesive, heat sealing, or another method recommended by the manufacturer. Do not use adhesive on areas of the geotextile fabric where flow is intended to occur.

If heat sealing is used, do not weaken the geotextile below the required strength values. Extend the geotextile below the bottom of the core far enough to completely encapsulate the collector pipe.

**(b) Geocomposite Sheet Drains.** Ensure that the horizontal and vertical flow of water within the sheet drain interconnects at all times for the full height of the core. Ensure that the drainage core with the geotextile in place provides a minimum flow rate of ½ gallon per minute per foot of width when tested in accordance with ASTM D 4716 under the following test conditions:

- (1) A specimen 12 inches long.
- (2) An applied load of 10 pounds per square inch.
- (3) A gradient of 0.1.
- (4) A 100-hour seating period.
- (5) A closed-cell foam rubber between platens and geocomposite.

If core construction separates the flow channel into two or more sections, only the flow rate on the inflow face is considered in determining the core's acceptability.

Firmly attach the geotextile to the core so folding, wrinkling, and other movement cannot occur either during handling or after placement. Achieve bonding using nonwater-soluble adhesive, heat sealing, or another method recommended by the manufacturer. Do not use adhesive on areas of the geotextile fabric where flow is intended to occur.

If heat sealing is used, do not weaken the geotextile below the required strength values. Extend the geotextile below the bottom of the core far enough to completely encapsulate at the collector pipe.

**(c) Geocomposite Pavement Edge Drains.** Ensure that the geotextile tightly encapsulates the geocomposite edge drain, and that the edge drains permit inflow from both sides. Ensure that the drain core with the geotextile in place provides a minimum flow rate of 15 gallons per minute per foot of width when tested in accordance with ASTM D 4716 under the following test conditions:

- (1) A specimen 12 inches long.
- (2) An applied load of 10 pounds per square inch.
- (3) A gradient of 0.1.
- (4) A 100-hour seating period.
- (5) A closed-cell foam rubber between platens and geocomposite.

If the geocomposite polymer core separates the flow channel into two or more parts, consider only the tested flow rate of the channel facing the pavement.

Firmly attach the geotextile to the core so folding, wrinkling, and other movement cannot occur during handling or after placement. Achieve bonding using nonwatersoluble adhesive, heat sealing, or another method recommended by the manufacturer. Do not use adhesive on areas of the geotextile fabric where flow is intended to occur.

If heat sealing is used, do not weaken the geotextile below the required strength values. Extend the geotextile below the bottom of the core far enough to completely encapsulate the collector pipe.

Furnish nonperforated plastic pipe conforming to Subsection 706.08 for all pipe and pipe fittings used for an outlet to the edge drain.

Furnish solvent cement for the outlet pipe and fittings in accordance with ASTM D 2564. Ensure that the material composition of the outlet fittings is compatible for direct solvent welding to PVC.

### 714.03 Geogrids

Furnish geogrids consisting of polymeric materials such as polypropylene, polyethylene, or polyester formed into a stable network of bars or straps fixed at their junctions such that the bars retain their relative position to each other. Ensure that the geogrid is treated to resist ultraviolet degradation, and that it conforms to the physical strength requirements shown in Table 714-7 in accordance with ASTM D 4595.

Table 714-7. - Physical strength requirements for geogrids.		
Category	Minimum Strength at 5% Strain (lb/ft)	Minimum Ultimate Strength at Breakage (lb/ft)
1	620	890
2	890	1440
3	1165	1990
4	1920	4180
5	3630	6715
6	4800	8565

Furnish the CO with a certificate signed by a legally authorized official from the company that manufactured the geogrid. Ensure that the certificate attests that the geogrid meets the chemical, physical, material, and manufacturing requirements stated in the specification. When requested by the CO, furnish a sample of the geogrid from each lot for verification testing.

During shipment and storage, wrap the geogrid in a heavy-duty protective covering. Protect the geogrid from mud, soil, dust, debris, and sunlight prior to installation.

Ensure that the geogrid meets the minimum average roll values for the wide-width strip tensile strength tests performed in accordance with ASTM D 4595 for the category

SHOWN ON THE DRAWINGS. Provide test results to the CO prior to incorporating the geogrid into the work.

Ensure that the aperture size for all geogrids is from 7/8 inch to 3 inches. Square and rectangular openings are permitted. Strengths shown in Table 714-7 are for both the machine and cross directions.

## **Section 715 - Piling**

### **715.01 Untreated Timber Piles**

Conform to ASTM D 25. Fabricate the piles from the following species for the sizes and dimensions as SHOWN ON THE DRAWINGS:

- (a) Douglas Fir
- (b) Larch
- (c) Norway Pine
- (d) Red Oak
- (e) Southern Yellow Pine

Install steel straps along the length of the pile at not more than 10-foot centers. In addition, place a strap at 3, 6, and 12 inches from the tip and two additional straps within 2 feet of the butt. Use 1 1/4-inch-wide by 1/32-inch-thick steel strapping material fabricated from cold-rolled, heat-treated, high-tensile steel with a minimum tensile strength of 5,000 pounds.

Hold straps in place with clips that are secured by crimping twice in the clip length with a notch-type sealer. Fabricate the clips from 2 1/4-inch by 1/32-inch-thick steel. The clip joint shall develop at least 75 percent of the strap tensile strength. Straps shall encircle the pile once and shall be tightened by hand-operated or power-assisted tensioning tools.

Furnish one copy each of the supplier's certification of species and the certification that the piling meets the requirements specified in ASTM D 25.

### **715.02 Treated Timber Piles**

Conform to Subsection 715.01, except furnish only Douglas Fir or Southern Yellow Pine piles for use in saltwater. Treat the piles with preservative in accordance with AASHTO M 133 for the types and quantities of preservatives as SHOWN ON THE DRAWINGS.

Use the pressure method procedure prescribed in AWWA standard C1. Apply the treatment to the piles after all millwork is completed.

Ensure that the treating plant imprints legible symbols or legends on the end of all piles, identifying the name of the treating company and type and year of treatment in accordance with AWWA standards M1 and M6.

Furnish one copy of the following Certificates of Compliance to the CO upon delivery of the piling to the jobsite:

- (a) Supplier certification of species, and certification that the piling meets the requirements specified in ASTM D 25.
- (b) Certificate of Conformance to AASHTO M 133, including type of treatment, retention (Assay method), and penetration from an ALSC-accredited agency.

Have the compliance certification made by a qualified testing and inspection agency.

### **715.03 Concrete Piles**

Fabricate piles from Class A (AE) concrete conforming to Section 552. Furnish billet steel and rail steel reinforcement bars conforming to Subsection 709.01. For prestressing reinforcement steel, conform to Subsection 709.03.

Construct precast concrete piles in accordance with Section 552. Construct prestressed concrete piles according to Section 553. When lifting anchors are used, maintain at least a 1-inch clearance from the pile reinforcing steel or prestressing steel.

Use metal, plywood, or dressed lumber forms that are watertight, rigid, and true-to-line. Use a 1-inch chamfer strip in all corners of the forms.

Cast piles separately or, if alternate piles are cast in a tier, cast the intermediate piles at least 4 days after the adjacent piles have been poured. Separate piles cast in tiers with tarpaper or other suitable separating material. Place concrete in each tier in a continuous operation that prevents the formation of stone pockets, honeycombs, and other defects. Leave forms in place for at least 24 hours.

When the forms are removed, make the pile surface true, smooth, even, and free from honeycombs and voids. Make piles straight so that a line stretched from butt to tip on any face will not be more than 1 inch from the face of the pile at any point.

Remove lifting anchors to a depth of at least 1 inch below the concrete surface, and fill the resulting hole with concrete. Finish the surface of each pile with a Class 1 ordinary surface finish, according to Subsection 552.18. Cure the piles in accordance with Sections 552 and 553, as applicable.

If concrete test cylinders are made and tested in accordance with Section 552, do not move piles until the tests indicate a compressive strength of at least 80 percent of the design 28-day compressive strength. Do not transport or drive piles until the tests indicate that the minimum design 28-day compressive strength has been attained.

If concrete test cylinders are not made, do not move piles until they have cured for at least 14 days at a minimum temperature of 60 °F, or 21 days at a minimum temperature of 40 °F. Do not transport or drive piles until cured for at least 21 days at a minimum of 60 °F, or 28 days at a minimum of 40 °F. When high-early-strength cement is used, do not move, transport, or drive piles until cured for at least 7 days.

#### 715.04 Steel Shells

Furnish either cylindrical or tapered pile shells of spiral welded, straight-seam welded, or seamless tube steel material. Use only one type of pile shell throughout a structure. Conform to the following minimum shell wall thickness:

- Outside cylinder diameter < 14 inches .....1/4 inch
- Outside cylinder diameter  $\geq$  14 inches.....3/8 inch
- Tapered or fluted .....3/16 inch

**(a) Shells Driven Without a Mandrel.** For tapered or step-tapered cast-in-place concrete piles, furnish shells having a minimum 12-inch diameter at cutoff and a minimum 8-inch diameter at tip. For constant-diameter cast-in-place concrete piles, furnish shells having a minimum nominal diameter of 10 5/8 inches.

Fabricate the shells from not less than 3/16-inch plate stock conforming to AASHTO M 183. Shells may be either spirally welded or longitudinally welded and either tapered or constant in section. Seal the tips as SHOWN ON THE DRAWINGS.

**(b) Shells Driven With a Mandrel.** Furnish shells of sufficient strength and thickness to withstand driving without injury and to resist harmful distortion and/or buckling due to soil pressure after being driven and the mandrel is removed. Butt and tip dimensions will be SHOWN ON THE DRAWINGS.

#### 715.05 Steel Pipes

Conform to the following:

- (a) Steel pipe to be filled with concrete .....ASTM A 252,  
Grade 2
- (b) Closure plates for closed end piles .....AASHTO M 183
- (c) Reinforced conical points for pipe closure at the tip .....AASHTO M 103
- (d) Unfilled tubular steel piles for welded and seamless  
steel pipe piles with chemical properties conforming to  
ASTM A 53, Grade B .....ASTM A 252,  
Grade 2

#### 715.06 Steel H-Piles

Furnish steel H-piles from rolled steel sections of the weight and shape SHOWN ON THE DRAWINGS. Fabricate the H-piles from structural steel conforming to AASHTO M 183, except do not use steel manufactured by the acid Bessemer treatment process.

For copper-bearing structural steel, furnish steel that contains not less than 0.20 percent or more than 0.35 percent copper.

#### **715.07 Sheet Piles**

Furnish steel sheet piles conforming to AASHTO M 202 or AASHTO M 223. Make the joints practically watertight when the piles are in place.

#### **715.08 Pile Shoes**

Furnish shoes for timber piles that are prefabricated from cast steel conforming to ASTM A 27.

#### **715.09 Splices**

Manufacture splices for H-piles or pipe piles from structural steel conforming to AASHTO M 183.

## **Section 716 - Material for Timber Structures**

### **716.01 Untreated Structural Timber & Lumber**

Furnish structural timber and lumber that conform to AASHTO M 168 and the applicable standards of the West Coast Lumber Inspection Bureau, Southern Pine Inspection Bureau, or another nationally recognized timber association. Ensure that all structural timber and lumber are seasoned and dried at the time of fabrication. Material that has become twisted, curved, or otherwise distorted prior to assembly into the final structure may be cause for rejection.

Do not use boxed-heart pieces of Douglas Fir or Redwood in stringer, floor beams, caps, posts, sills, curbs, rails, rail posts, and rail post blocks. Boxed-heart pieces are defined as timber so sawed that at any point in the length of a sawed piece, the pith lies entirely inside the four faces.

Legibly mark, stamp, or brand all pieces, identifying the inspection service, grade designation, species, and identity of the inspector. Furnish timber and lumber that conform to the species, design values, and nominal dimensions SHOWN ON THE DRAWINGS. Furnish an inspection certification as to the species and grade from an agency accredited by ALSC.

### **716.02 Hardware & Structural Steel**

Furnish machine and carriage bolts that meet the requirements of ASTM A 307, drift pins and dowels that meet the requirements of ASTM A 575, and galvanized hardware that meets the requirements of AASHTO M 232.

Ensure that all structural steel shapes, rods, glued laminated deck panel dowels, and plates are structural steel that meets the requirements of AASHTO M 183. Ensure that galvanizing meets the requirements of AASHTO M 111.

Furnish bolts with square or hexagonal heads, nuts or dome-headed bolts as SHOWN ON THE DRAWINGS, and nails that are cut or round nails of standard form. Use cut, round, or boat spikes, as specified. Use washers that are malleable iron castings, and plain or cut washers that are American Standard Plain Washers.

Use ring or shear plate timber connectors conforming to AASHTO's "Standard Specifications for Highway Bridges," Division II, article 16.2.6, Timber Connectors.

### **716.03 Treated Structural Timber & Lumber**

Furnish wood in accordance with Subsection 716.01. Treat the wood and mark each piece of treated timber in accordance with AASHTO M 133. Use the type of treatment and minimum net retention of preservative that are SHOWN ON THE DRAWINGS. Completely and accurately fabricate all treated timber before it is treated. Except for Southern Pine, incise all surfaces greater than 2 inches in width; including glued laminated members, before treatment. Treat glued laminated timbers in accordance with

AWPA C28. Furnish inspection certification of treatment from an agency accredited by ALSC.

Use the assay method to determine retention of preservatives in all lumber and timbers.

Ensure that treatment meets the requirements in the current edition of the WWPI's "Best Management Practices for the Use of Treated Wood in Aquatic Environments."

#### **716.04 Structural Glued Laminated Timber**

Furnish structural glued laminated timber that meets the requirements specified in the current edition of AITC 117. Use the combination symbol, protection, quality marks, certificates, and preservation treatment that are SHOWN ON THE DRAWINGS. Ensure that manufacture, marking, and quality control of structural glued laminated timber are in conformance with ANSI/AITC A190.1, Structural Glued Laminated Timber.

Ensure that members are manufactured as industrial-appearance grade for wet use conditions, using a phenol-resorcinol resin type of adhesive throughout. Use only single- or multiple-piece laminations with boded edge joints.

Ensure that caulking compound used to seal deck panel joints meets the requirements of FSS TT-S-001543 (com.) and is brown or bronze in color.

#### **716.05 Substitution for Solid Sawn Structural Timber & Lumber**

Comparable glued laminated material may be substituted for solid sawn material. Ensure that all substitutions have approximately equal dimension and will provide equal or greater bonding and shear strength per member. Before fabrication, submit drawings that show revised details, including any changes in dimensions, elevation, and bolt length.

## Section 717 - Structural Metal

### 717.01 Structural Steel

Furnish structural carbon steel in accordance with AASHTO M 270 and as shown below.

**(a) Structural Carbon Steel.** For primary bridge members, furnish structural carbon steel that conforms to AASHTO M 270, Grade 36T. For fracture-critical bridge members, furnish structural carbon steel that conforms to AASHTO M 270, Grade 36F. For other shapes, plates, and bars, furnish structural carbon steel that conforms to AASHTO M 270, Grade 36.

**(b) High-Strength Low-Alloy (HSLA) Structural Steel.** For other shapes, plates, and bars, furnish HSLA steel that conforms to AASHTO M 270, Grade 50 or 50W.

For primary bridge members, furnish HSLA steel that conforms to AASHTO M 270, Grade 50T or 50WT. Ensure that fracture-critical bridge members conform to AASHTO M 270, Grade 50F or 50WF.

For welded members, furnish HSLA steel that conforms to AASHTO M 270, Grade 50T or 50WT. Ensure that fracture-critical welded members conform to AASHTO M 270, Grade 50F or 50WF.

**(c) High-Strength Quenched & Tempered Steel.** For other shapes, plates, and bars, ensure that all quenched and tempered steel provided conforms to AASHTO M 270, Grade 70W, 100, or 100W. For primary bridge members, furnish quenched and tempered steel that conforms to AASHTO M 270, Grade 70WT, 100T, or 100WT. Furnish fracture-critical bridge members that conform to AASHTO M 270, Grade 70WF, 100F, or 100WF.

**(d) Bolts & Nuts.** Conform to ASTM A 307.

**(e) High-Strength Bolts, Nuts, & Washers.** Conform to either AASHTO M 164 or AASHTO M 253, as specified. Furnish circular, clipped, and beveled hardened steel washers that conform to AASHTO M 293 (ASTM F 436).

**(f) Load-Indicating Washers.** Furnish load-indicating washers that conform to ASTM F 959, Type 325 or 490. Use Type 325 with AASHTO M 164 bolts, and Type 490 with AASHTO M 253 bolts.

**(g) Steel Anchor Bolts.** Furnish steel anchor bolts that conform to AASHTO M 314 and are of the grade and dimensions SHOWN ON THE DRAWINGS. Ensure that the exposed portion of the bolt is zinc coated by hot dip or mechanical deposition.

### **717.02 Steel Forgings**

Conform to AASHTO M 102, Classes C, D, F, and G.

### **717.03 Pins & Rollers**

Furnish pins and rollers that are more than 9 inches in diameter from annealed carbon-steel forgings that conform to AASHTO M 102, Class C.

Furnish pins and rollers that are 9 inches or less in diameter either from annealed carbon-steel forgings that conform to AASHTO M 102, Class C, or from cold finished carbon-steel shafting that conforms to AASHTO M 169, Grade 1016 to 1030, inclusive, with a minimum Rockwell Scale B hardness of 85. The hardness requirement may be waived if the steel develops a tensile strength of 70,000 pounds per square inch and a yield point of 36,000 pounds per square inch.

Furnish pin threads that conform to the ANSI B1.1 Coarse Thread Series, Class 2A. Thread pin ends with a diameter of 1 3/8 inches or more with six threads in 1 inch.

### **717.04 Castings**

Furnish castings that conform to the following:

**(a) Steel Castings.** Furnish steel castings that conform to AASHTO M 192, Class 70.

**(b) Chromium Alloy Steel Castings.** Furnish chromium alloy steel castings that conform to AASHTO M 163, Grade CA-15.

**(c) Gray Iron Castings.** Furnish gray iron castings that conform to AASHTO M 105, Class Number 30B, unless otherwise specified. Furnish iron castings that are free from pouring faults, sponginess, cracks, blow holes, and other defects in position affecting their strength and value for the service intended. Boldly fillet the castings at angles and make the arrises sharp and perfect. Sand blast all castings, or otherwise effectively remove the scale, and sand to present a smooth, clean, and uniform surface.

**(d) Malleable Iron Castings.** Furnish malleable iron castings that conform to ASTM A 47, Grade Number 35018, unless otherwise specified. Ensure that workmanship, finishing, and cleaning conform to Subsection 717.04(c).

### **717.05 Welded Stud Shear Connectors**

Furnish shear connector studs that conform to AASHTO M 169 for standard-quality, cold-finished, carbon steel bars. Provide the connectors conforming to AASHTO's "Standard Specifications for Highway Bridges," Division II, article 11.3.3, Welded Stud Shear Connectors.

### **717.06 Steel Pipe**

Furnish galvanized steel pipe conforming to ASTM A 53, Type F, standard weight class, and plain ends for the designation SHOWN ON THE DRAWINGS.

**717.07 Galvanized Coatings**

When galvanizing is specified, galvanize structural steel shapes, plates, bars, and their products in accordance with AASHTO M 111. Galvanize hardware in accordance with AASHTO M 232.

**717.08 Sheet Lead**

Furnish sheet lead that conforms to ASTM B 29 for common desilverized lead. Furnish the sheets in a uniform thickness of ¼ inch ± 1/32 inch, and make them free from cracks, seams, slivers, scale, and other defects.

**717.09 Steel Grid Floors**

Furnish steel grid floors that conform to AASHTO M 270, Grade 36 or 50W. Ensure that steel furnished in accordance with AASHTO M 270, Grade 36, has a minimum copper content of 0.2 percent unless galvanized. Galvanize steel grid floors unless painting is specified.

**717.10 Elastomeric Bearing Pads**

Furnish elastomeric bearing pads that conform to AASHTO M 251.

**717.11 TFE Surfaces for Bearings**

**(a) TFE Resin.** Furnish virgin TFE resin material conforming to ASTM D 1457. Ensure that specific gravity is 2.13 to 2.19 and the melting point is 623 °F ± 2 °F.

**(b) Filler Material.** Furnish filler material consisting of milled glass fibers, carbon, or other approved inert material.

**(c) Adhesive Material.** Furnish epoxy resin adhesive conforming to FSS MMM–A–134, FEP film, or an approved equivalent.

**(d) Unfilled TFE Sheet.** Furnish unfilled TFE sheet from TFE resin conforming to the following:

(1) Min. tensile strength, ASTM D 1457 .....2,800 psi

(2) Min. elongation, ASTM D 1457 .....200%

**(e) Filled TFE Sheet.** Furnish filled TFE sheet from TFE resin uniformly blended with inert filler material. For filled TFE sheets containing glass fiber or carbon, conform to specifications in Table 717-1.

**(f) Fabric Containing TFE Fibers.** Furnish fabric from oriental multifilament TFE fluorocarbon and other fibers. Use TFE fibers that conform to the following:

(1) Min. tensile strength, ASTM D 2256 .....24,000 psi

(2) Min. elongation, ASTM D 2256 .....75%

Table 717-1. - TFE sheeting.			
Property	ASTM Method	15% Glass fibers	25% Carbon
Mechanical:			
Minimum tensile strength	D 1457	2,000 psi	1,300 psi
Minimum elongation	D 1457	150%	75%
Physical:			
Minimum specific gravity	D 792	2.20	2.10
Melting point	D 1457	620 ± 18 °F	620 ± 18 °F

**(g) Interlocked Bronze & Filled TFE Components.** Furnish interlocked bronze and filled TFE components that consist of a phosphor bronze plate conforming to ASTM B 100 with an 0.01-inch-thick porous bronze surface layer conforming to ASTM B 103M, into which a TFE compound is impregnated. Overlay the surface with compounded TFE not less than 0.001-inch-thick.

**(h) TFE Metal Composite.** Furnish virgin TFE molded on each side and completely through a 1 3/8 inch perforated stainless steel sheet conforming to ASTM A 240, Type 304.

**(i) Surface Treatment.** For epoxy bonding, factory treat one side of the TFE sheet with a sodium naphthalene or sodium ammonia process.

**(j) Stainless Steel Mating Surface.** Furnish stainless steel mating surfaces that are at least 1/32 inch thick, conform to ASTM A 240, Type 304, and have a surface finish less than 20 μ inches root mean square. Polish or roll stainless steel mating surfaces as necessary to provide the specified friction properties.

### 717.12 Structural Aluminum Alloy

Furnish structural aluminum material that conforms to the requirements SHOWN ON THE DRAWINGS and to “Specifications for Aluminum Structures,” published by the Aluminum Association, Inc. (AA). For aluminum expansion joint material, furnish aluminum extrusion alloy 6061-T6.

### 717.13 Aluminum Alloy for Bridge Rail

Furnish aluminum alloys that conform to the applicable specifications of Table 717-3, as specified.

#### **717.14 Aluminum Bolt Heads & Nuts**

Furnish aluminum bolt heads and nuts that conform to American Standard heavy hexagon ANSI B18.2. Ensure that threads conform to American Standard coarse series, Class 2 fit, ANSI specification B1.1.

#### **717.15 Aluminum Welding Wire**

Furnish aluminum welding wire that conforms to the specifications in Table 717-2.

Table 717-2. - Aluminum welding wire.		
<b>Alloy Series</b>	<b>Specifications</b>	<b>Wire</b>
3xxx and 6xxx	AWS 5.10	ER 4043
3xxx, 5xxx, and 6xxx		ER 5356
5xxx, and 6xxx		ER 5556 or 5183

#### **717.16 Elastomeric Compression Joint Seals**

Furnish elastomeric compression joint seals that conform to AASHTO M 220.

#### **717.17 Dowels**

Furnish dowels that conform to the requirements of AASHTO M 31 (ASTM A 615) for Grades 40 and 60, or AASHTO M 227 (ASTM A 663) for Grades 70, 75, and 80.

Table 717-3. - Aluminum alloys for bridge railing systems (ASTM and AA alloy designation).

Railing Component	Sheet and Plate	Drawn Formless Tubes	Bars, Rods, and Wire	Extruded Bars, Rods, Shapes, and Tubes	Pipe	Standard Structural Shapes	Rivet Cold and Heading Wires and Rods	Sand Castings	Permanent Mold Castings
<i>ASTM Specification</i>	<i>B 209</i>	<i>B 210</i>	<i>B 211</i>	<i>B 221</i>	<i>B 241</i>	<i>B 308</i>	<i>B 316</i>	<i>B 26</i>	<i>B 108</i>
Posts and post bases, structural: Wrought				6061-T6	6061-T6	6061-T6			
Cast					6063-T6				A444.0-T4
Posts, ornamental: Wrought				6063-T6	6063-T6			356.0-T6	A356.0-T6
Cast								356.0-T6	A356.0-T6
Rails and sleeves, structural: Wrought		6061-T6 6063-T6		6061-T6 6063-T6 6351 T5	6061-T6 6063-T6	6061-T6			
Bolts and screws, misc: <sup>a,b</sup> Aluminum, Wrought Stainless Steel Galvanized steel Aluminized steel			2024-T4 <sup>c</sup> 6021-T6 <sup>d</sup>						
Nuts, <sup>e</sup> wrought: ¼ inch and under <sup>b</sup>			2024-T4	6061-T6 <sup>f</sup>					
¾ inch and over			6061-T6						
Washers, flat: <sup>b</sup> Wrought	Alclad 2024-T4 Alclad 2024-T3 <sup>h</sup>								
Washers, spinglock: <sup>b</sup> Wrought			7075-T6						
Rivets: Wrought				6061-T6			6061-T6 <sup>g,i</sup> 6061-T4 <sup>g,j</sup>		
Shims: Wrought Cast	1100-0			6063-F <sup>g</sup>				443.0-F	
Weld filler: Wrought						5356			
End caps: Wrought Cast	6061-T6			6061-T6				356.0-T6 <sup>g</sup> 356.0-F 443.0-F	

Note: "F" temper applies to products that acquire some temper from fabricating processes.

- a. Use compatible stainless or coated steel nuts and washers. Do not use aluminum for anchor bolts.
- b. Coat alloy 2024-T4 with a 5  $\mu\text{m}$  minimum thickness anodic coating with a dichromate or boiling water seal.
- c. Use alloy 2024-T4 for stress-carrying bolts and minor bolts.
- d. Use alloy 6061-T6 as an alternate material for minor bolts.
- e. Use with aluminum bolts and screws. Do not use aluminum for anchor bolt nuts and washers.
- f. ASTM B 211 is an acceptable alternate.
- g. Chemical, composition only.
- h. Use T3 temper for thicknesses less than  $\frac{1}{4}$  inch, and use T4 temper for thicknesses  $\frac{1}{4}$  inch and greater.
- i. Use for cold-driven rivets.
- j. Use for rivets driven at 990 °F to 1050 °F.

## **Section 718 - Traffic Signing & Marking Material**

### **718.01 Retroreflective Sheeting**

Furnish retroreflective sheeting material that conforms to AASHTO M 268, except that the minimum coefficients of retroreflection for brown Type I sheeting shown in AASHTO M 268, Table 1, are amended as follows:

- (a) 2.0 candela/footcandle/square foot at 0.2° observation angle and – 4° entrance angle.
- (b) 1.0 candela/footcandle/square foot at 0.2° observation angle and + 30° entrance angle, and at 0.5° observation angle and – 4° entrance angle.
- (c) 0.5 candela/footcandle/square foot at 0.5° observation angle and + 30° entrance angle.

Furnish retroreflective sheeting material that conforms to AASHTO M 268 supplemental requirement S1, if specified. Furnish reboundable retroreflective sheeting that conforms to AASHTO M 268, including supplemental requirement S2.

Furnish sheeting that is either heat activated or pressure sensitive (Class 1), engineer grade, unless otherwise specified. Ensure that colors are as specified in the MUTCD and as SHOWN ON THE DRAWINGS.

Ensure that no more than 12 months elapse from the date of manufacture to the date of application.

When an adhesive is used, use backing Class 1, 2, or 3, in accordance with AASHTO M 268.

### **718.02 Test Procedures**

Use test procedures in accordance with AASHTO M 268, except that subsection S1.3.3 is amended as follows:

The stock cultures of *Aspergillus niger*, American Type Culture Collection number 6275, may be kept for not more than 4 months in a refrigerator at a temperature from 37 °F to 50 °F. Use subcultures incubated at 82 °F to 86 °F for 10 to 14 days in preparing the inoculum.

### **718.03 Plywood Panels**

Fabricate the panels from HDO plywood, two sides Douglas Fir, exterior type, conforming to U.S. Product Standard 1 (current edition), with a B-grade veneer or better on both faces. Ensure that surfacing overlay material is high-density 90–90 resin-impregnated fiber, permanently fused to the base panel under heat and pressure. Furnish material that is suitable for sign manufacturing and compatible with reflective-sheeting

adhesive. Do not permit any marks, blemishes, or damage of any kind. Overlay color may be either black or buff, unless specified otherwise. Ensure that each panel edge-brand includes the following: HDO B–B G1 EXT APA PS 1.

Use a minimum ½-inch-thick plywood for signs less than 24 inch in the longest dimension. Use a minimum 9/16-inch-thick plywood for all other signs cut from a single sheet. Use a minimum ¾-inch-thick plywood for all signs requiring joining.

Abrade, clean, and degrease the face of the plywood panel in accordance with methods recommended by the manufacturer of the retroreflective sheeting. Treat the edges of the plywood panel with an approved edge sealant.

#### **718.04 Steel Panels**

Fabricate the panels from 1/16-inch continuous-coat galvanized sheet steel blanks conforming to ASTM A 525. Mill phosphatize the zinc coating (designation G 90) to a thickness of  $0.0035 \pm 0.00165$  ounces per square foot of surface area.

The finished plate shall be free of twist or buckles and the background substantially a plane surface. Clean, degrease, or otherwise prepare the panels in accordance with methods recommended by the sheeting manufacturer.

#### **718.05 Aluminum Panels**

Furnish sheets and plates that conform to ASTM B 209, alloy 6061–T6 or 5052–H38.

Fabricate temporary panels and permanent panels that are 30 x 30 inches or smaller from 1/16-inch-thick aluminum sheets. Fabricate larger permanent panels from 1/8-inch-thick aluminum sheets.

Furnish blanks that are free from laminations, blisters, open seams, pits, holes, and other defects that may affect their appearance or use. Ensure that thickness is uniform and the blank commercially flat. Perform shearing, cutting, and punching before preparing the blanks for application of reflective material.

Clean, degrease, and chromate the blanks, or otherwise properly prepare the panels in accordance with methods recommended by the sheeting manufacturer.

#### **718.06 Plastic Panels**

**(a) Plastic.** Fabricate the panels from sheets of lightweight, flexible, high-impact, and ultraviolet-chemical-resistant polycarbonate material or approved equivalent that will accept adhesives, coatings, and retroreflective sheeting material, as recommended for such material.

Fabricate panels that are 24 x 24 inch or smaller from 1/16 inch-thick plastic blanks. Fabricate larger panels from 1/8-inch-thick plastic blanks.

Furnish panels that are flat and free of buckles, warps, and other defects. Where multiple panels adjoin, ensure that the gap between adjacent panels is no greater than 5/8 inch. Ensure that signs larger than 24 x 24 inches have reinforcement stiffeners attached on the back for rigidity and for mounting on the supports.

**(b) Fiberglass-Reinforced Plastic.** Fabricate fiberglass-reinforced plastic signs from fiberglass-reinforced thermoset polyester acrylic modified laminate sheets. Furnish sign panel that is ultraviolet stabilized for outdoor weathering ability. Ensure that sign panel accepts adhesives, coatings, and retroreflective sheeting material, as recommended.

Furnish sign panel free of visible cracks, pinholes, foreign inclusions, and surface wrinkles that would affect implied performance, alter the specific dimensions of the panel, or otherwise affect the sign panel's serviceability.

Wipe sign panel surface clean with a slightly dampened cloth before applying reflective sheeting.

Furnish fiberglass-reinforced plastic that complies with the recommendations of the Fiberglass Reinforced Panel Council publication "Recommended Traffic Control Sign Panel Specification." Unless otherwise SHOWN ON THE DRAWINGS, furnish material that is brown, matching FSS 595a, color number 20059.

#### **718.07 Extruded Aluminum Panels**

Fabricate the panels from aluminum alloy 6063-T6 conforming to the requirements of ASTM B 221. Ensure that panel thickness and fabrication conform to Subsection 718.05. The maximum allowable deviation from flat on the face is 1/16 inch per foot.

#### **718.08 Paint**

Furnish premium-grade exterior silicone alkyd enamel paint with a color to match the color of the HDO plywood substrate.

#### **718.09 Silk Screen Inks**

Furnish inks that are compatible with the sheeting, as determined by the manufacturer of the ink and the manufacturer of the sheeting. Furnish color as specified in the MUTCD and as SHOWN ON THE DRAWINGS.

#### **718.10 Edge Film**

Furnish edge film that is a pressure-sensitive, premium-quality, clear, ultraviolet-resistant, 3 inch-wide vinyl film.

#### **718.11 Signposts**

Fabricate traffic signposts from wood, steel, plastic, aluminum, or fiberglass-reinforced plastic, as specified.

**(a) Wood Posts.** Fabricate wood posts from dry number 1 structural-grade Douglas Fir, Southern or Ponderosa Pine, Hemlock, Spruce, or Western Larch conforming to AASHTO M 168. Treat the posts with waterborne preservative ACA, ACZA, or CCA, in accordance with AWP standard C14, but ensure that the minimum preservative retention is 0.40 pounds per cubic foot.

**(b) Steel Posts.** Fabricate steel posts from billet or rail steel conforming to ASTM A 499. Drill or punch 3/8-inch holes in the posts along the centerline of the web before galvanizing. Begin punching or drilling 1 inch from the top of the post and proceed on 1-inch centers for the entire length of the post. Galvanize the posts in accordance with ASTM A 123.

**(c) Aluminum Posts.** Fabricate aluminum posts in approved standard shapes and thicknesses using aluminum alloy 6061-T6, 6351-T5, 6063-T6, or 6005-T5 conforming to ASTM B 221.

**(d) Plastic Posts.** Fabricate flexible posts made with high-impact-resistant, ultraviolet, chemical-resistant polycarbonate material or approved equivalent.

**(e) Fiberglass-Reinforced Plastic Posts.** Fabricate fiberglass-reinforced plastic posts from fiberglass-reinforced thermoset polymers. Post to be ultraviolet stabilized for outdoor weathering ability.

#### **718.12 Object Marker & Delineator Posts**

Fabricate object marker and delineator posts from wood, steel, aluminum, plastic, or fiberglass-reinforced plastic.

**(a) Wood Posts.** Furnish 4 x 4-inch wood posts that conform to Subsection 718.11.

**(b) Steel Posts.** Furnish flanged U-channel steel posts that weigh not less than 2 pounds per foot and conform to ASTM A 36. Galvanize the posts in accordance with ASTM A 123.

**(c) Aluminum Posts.** Furnish standard-shaped 1/8-inch-thick aluminum posts conforming to ASTM B 221, alloy 6061-T6.

**(d) Plastic Posts.** Furnish flexible delineator posts made with high-impact-resistant, ultraviolet-chemical-resistant polycarbonate or approved equivalent.

**(e) Fiberglass-Reinforced Plastic Posts.** Fabricate fiberglass-reinforced plastic posts from fiberglass-reinforced thermoset polymers. Post to be ultraviolet stabilized for outdoor weathering ability.

#### **718.13 Hardware**

Use galvanized steel or aluminum alloy for fittings such as lag screws, washers, clip angles, wood screws, shear plates, U-bolts, clamps, bolts, nuts, and other fasteners.

Furnish high-strength steel bolts, nuts, and washers conforming to specifications in Subsection 717.01. Galvanize steel hardware in accordance with ASTM A 153.

Furnish aluminum alloy bolts, nuts, and washers conforming to specifications in Subsections 717.13 and 717.14, as applicable.

Furnish oversize bolt heads and oversize neoprene or nylon washers for plastic sign panels.

#### **718.14 Letters, Numerals, Arrows, Symbols, & Borders**

Furnish colors as SHOWN ON THE DRAWING and in accordance with Subsection 718.01 and the FHWA's "Standard Alphabets for Highway Signs," current edition.

Perform all silk-screening operations precisely as prescribed in writing by the manufacturers of the ink and the sheeting to which they are applied.

Furnish silk screen inks that are color matched to eliminate any visual difference between silk-screened material and applied material of the same color on the same sign.

Form letters, numerals, and other units to provide a continuous stroke width with smooth edges. Make the surface flat and free of warp, blisters, wrinkles, burrs, and splinters. Ensure that units of the sign message conform to the following:

**(a) Type L-1 (Screen Process).** Apply letters, numerals, arrows, symbols, and borders on the retroreflective sheeting or opaque background of the sign by direct or reverse screen process. Apply messages and borders that are of a darker color than the background to the paint or the retroreflective sheeting by direct process. Produce messages and borders that are of a lighter color than sign background by the reverse screen process.

Use opaque or transparent colors, inks, and paints in the screen process of the type and quality recommended by the retroreflective sheeting manufacturer.

Perform the screening in a manner that results in a uniform color and tone, with sharply defined edges of legends and borders and without blemishes on the sign background that will affect intended use.

Air dry or bake the signs after screening in accordance with manufacturer's recommendations to provide a smooth, hard finish. Any signs with blisters or other blemishes will be rejected.

**(b) Type L-3 (Direct-Applied Characters).** Cut letters, numerals, symbols, borders, and other features of the sign message from the type and color of the retroreflective sheeting specified and apply them to the sign background's retroreflective sheeting in accordance with the retroreflective sheeting manufacturer's instructions. Ensure that the retroreflective sheeting has a minimum coefficient of retroreflection ( $R_A$ ) in accordance with ASTM D 4956.

### 718.15 Delineator & Object Marker Retroreflectors

Retroreflector units for delineators and object markers are either Type 1 (acrylic plastic lens) or Type 2 (retroreflective sheeting). Furnish the units ready for mounting.

**(a) Type 1 (Acrylic Plastic Lens).** The retroreflector unit has an acrylic plastic lens with a minimum area of 7 square inches prismatic optical elements, and a smooth, clear, transparent face. Fabricate the back from similar material and fuse it to the lens round the entire perimeter to form a homogenous unit. Retroreflection is provided by the lens prismatic optical elements. Permanently seal the units against the intrusion of dust, water, and air.

Ensure that the coefficient of (retroreflective) luminous intensity of each retroreflector unit equals or exceeds the minimum values shown in Table 718-1, regardless of the orientation angle.

Mount the retroreflector unit in a housing fabricated from 1/16-inch aluminum alloy 3003-H-14 or similar material, or from cold-rolled, hot dip galvanized steel with a thickness of 1/16 inch. Provide antitheft attachment hardware.

Table 718-1. - Minimum coefficient of (retroreflective) luminous intensity ( $R_1$ ) (candelas per foot-candle).				
Observation Angle (°)	Entrance Angle (°)	White <sup>a</sup>	Yellow	Red
0.1	0	115	70	30
0.1	20	45	25	12

<sup>a</sup> Crystal, clear, or colorless are acceptable color designations.

**(b) Type 2 (Retroreflective Sheeting).** The retroreflector unit is composed of a fungus-resistant Type III, Type IV, or Type V retroreflective sheeting material with a Class 1 or Class 2 adhesive backing conforming to AASHTO M 268.

Attach Type 2 retroreflective units to an aluminum or plastic support panel (target plate) of the size and dimension specified. Type 1 units require a sealed optical system complete with housing and assembly hardware and do not require attachment to a support panel unless otherwise specified.

Furnish post-mounting antitheft hardware consisting of bolts, nuts, washers, fastening plates, brackets, and so forth, as required.

### 718.16 Conventional Traffic Paint

Furnish an alkyd resin ready-mixed paint for use on asphalt and Portland cement concrete pavements conforming to FSS TT-P-115F.

**718.17 Waterborne Traffic Paint**

Furnish an acrylic water-based ready-mixed paint for use on asphalt and Portland cement concrete pavements conforming to the following:

**(a) Composition.** Furnish a paint composed of resin solids of 100 percent acrylic polymer with the exact formulation determined by the manufacturer. Conform to the following:

- (1) Pigment, by mass, ASTM D 3723 .....45 to 55%
- (2) Nonvolatile vehicle, by mass, FTMS 141, method 6121 .....40% min.
- (3) Lead, chromium, cadmium, or barium .....0%
- (4) Volatile organic matter .....33.4 oz/gal max..
- (5) Mass of paint, ASTM D 1475 .....12 lb/gal min.

**(b) Viscosity.** Conform to ASTM D 562, 75 to 95 Krebs units.

**(c) Drying Time.** Conform to the following:

- (1) Paint shall dry to a no-pickup condition, according to ASTM D 711, in a maximum of 10 minutes.
- (2) Paint having 6 lb/Gal Type 1 waterproofed glass beads shall dry to a nottracking condition under traffic in a maximum of 90 seconds when applied at  $15 \pm 1$  mil wet film thickness at 130 °F, or in a maximum of 10 minutes when applied at ambient temperatures.

**(d) Flexibility.** Conform to FSS TT-P-1952B. No cracking or flaking.

**(e) Dry Opacity.** Conform to FTMS 141, contrast ratio at 0.010 inch, 0.96 minimum.

**(f) Color.** Conform to the following:

- (1) White .....FHWA standard highway white
- (2) Yellow .....FHWA standard highway yellow

**(g) Daylight Reflectance.** Conform to the following, without glass beads:

- (1) White, FTMS 141, method 6121 .....84% relative to magnesium oxide standard

(2) Yellow, FTMS 141, method 6121 .....55% relative to magnesium oxide standard

**(h) Bleeding Ratio.** Conform to FSS TT-P-1952B, 0.96 minimum.

**(i) Scrub Resistance.** Conform to ASTM D 2486, 300 cycles minimum.

**(j) Freeze-Thaw Stability.** Conform to FSS TT-P-1952B:

(1) Change in consistency .....± 5 Krebs units max.

(2) Decrease in scrub resistance .....-10% max.

**(k) Storage Stability.** During a 12-month storage period, conform to the following:

(1) No excessive setting, caking, or increase in viscosity.

(2) Readily stirred to a consistency for use in the striping equipment.

### 718.18 Epoxy Markings

Formulate a two-component, 100-percent-solids type system for hot-spray application conforming to the following:

**(a) Pigments.** Furnish component A (percent by weight) as follows:

(1) White:

(a) Titanium dioxide (TiO<sub>2</sub>), ASTM D 476, Type II  
(16.5% min. at 100% purity) .....18% min.

(b) Epoxy resin .....75 to 82%

(2) Yellow:

(a) Chrome yellow (PbCrO<sub>4</sub>), ASTM D 211, Type III  
(20% min. at 100% purity) .....23% min.

(b) Epoxy resin.....70 to 77%

**(b) Epoxy Content.** For component A (weight per epoxy equivalent), ASTM D 1652, meet manufacturer's TV ± 50.

**(c) Amine Value.** For component B, ASTM D 2074, meet manufacturer's TV ± 50.

**(d) Toxicity.** Do not permit toxic or injurious fumes at application temperature.

**(e) Color.** Furnish 15-mil film thickness (cured), as follows:

- (1) White .....FHWA standard  
highway white
- (2) Yellow .....FHWA standard  
highway yellow

**(f) Directional Reflectance.** Furnish directional reflectance without glass beads as follows:

- (1) White, FSS 141, method 6121 .....84% relative to  
magnesium oxide  
standard
- (2) Yellow, FSS 141, method 6121 .....55% relative to  
magnesium oxide  
standard

**(g) Drying Time.** Furnish 15-mil film thickness with beads as follows:

- (1) Laboratory at 72 °F, ASTM D 711 .....30 min max. to  
no-pickup  
condition
- (2) Field at 77 °F, viewed from 50 ft .....10 min max. to  
no-tracking  
condition

**(h) Abrasion Resistance.** Ensure that wear index with a CS-17 wheel under a 35.3 oz. load for 1,000 cycles, ASTM C 501, is a maximum of 82.

**(i) Hardness.** Ensure that shore D hardness with 72- to 96-hour cure at 72 °F, ASTM D 2240, is 75 to 100.

**(j) Storage.** When stored for up to 12 months, individual epoxy components do not require mixing before use.

### 718.19 Polyester Markings

Formulate a two-component system conforming to the following:

(a) Directional reflectance (without glass beads):

- (1) White, FSS 141, method 6121 .....80% relative to  
magnesium oxide  
standard

(2) Yellow, FSS 141, method 6121 .....	55% relative to magnesium oxide standard
(b) Color:	
(1) White .....	FHWA standard highway white
(2) Yellow .....	FHWA standard highway yellow
(c) Viscosity, uncatalyzed polyester at 25 °F, ASTM D 562.....	70 to 90 Krebs
(d) Bleeding, ASTM D 969 .....	6 min.
(e) Drying time in field, viewed from 50 ft .....	45 min. max. to no tracking condition

**718.20 Thermoplastic Markings**

Conform to AASHTO M 249.

**718.21 Preformed Plastic Markings**

Furnish thermoplastic material consisting of a mixture of polymeric material, pigments, and glass beads homogeneously distributed throughout. Embed additional glass beads into the retroreflective surface. Provide a precoated adhesive system or liquid contact cement to make the marking material capable of being attached to asphalt and Portland cement pavements.

Ensure that the marking material molds itself to pavement contours by the action of traffic at normal pavement temperatures. Furnish marking material that can be used for patching worn areas of previously applied markings of similar composition under normal conditions of use.

Furnish material that conforms to ASTM D 4505, Type I, V, VI, or VII, Grade A, B, C, D, or E.

Ensure that the minimum thickness without adhesive is 1/16 inch. Ensure that a matrix with a raised pattern cross-sectional area has a minimum thickness of 1/64 inch between pattern configurations.

### 718.22 Glass Beads

Furnish glass beads for dropping or spraying on pavement markings that conform to AASHTO M 247 for the type specified. Treat glass beads with an adherence coating, as recommended by manufacturer.

AASHTO M 247, Table 1, Gradation of Glass Beads, is supplemented by the gradations of glass beads shown in Table 718-2.

Ensure that Type 3, 4, and 5 glass beads also conform to the following:

- (a) Treat beads with a reactive adherence coating, as recommended by the manufacturer.
- (b) Ensure that roundness, FLH T 520, conforms to 70 percent minimum for each sieve size.
- (c) Ensure that the refractive index, AASHTO M 247, is from 1.50 to 1.55.

Table 718-2. - Gradation of glass beads.

Sieve Size	Percent by Weight Passing Designated Sieve ASTM D 1214		
	Grading Designation		
	Type 3	Type 4	Type 5
No. 8	-	-	100
No. 10	-	100	95 – 100
No. 12	100	95 – 100	80 – 95
No. 14	95 – 100	80 – 95	10 – 40
No. 16	80 – 95	10 – 40	0 – 5
No. 18	10 – 40	0 – 5	0 – 2
No. 20	0 – 5	0 – 2	-
No. 25	0 – 2	-	-

### 718.23 Raised Pavement Markers

Furnish prismatic retroreflector-type markers consisting of a methyl methacrylate, polycarbonate, or suitably compounded ABS shell fitted with retroreflective lenses. Make the exterior surface of the shell smooth.

Use a retroreflector with a minimum coefficient of (retroreflected) luminous intensity conforming to Table 718-3.

Make the base of the marker flat, patterned, or textured and free from gloss or substances that may reduce its bond to the adhesive. Do not permit deviation from a flat surface to exceed 1/32 inch.

Table 718-3. - Minimum coefficient of (retroreflected) luminous intensity (R <sub>l</sub> ) Candelas per footcandle				
Observation Angle (°)	Entrance Angle (°)	White <sup>a</sup>	Yellow	Red
0.2	0	3.0	1.8	0.75
0.2	20	1.2	0.72	0.30

<sup>a</sup> Crystal, clear, or colorless are acceptable color designations.

### 718.24 Temporary Pavement Markings

**(a) Preformed Retroreflective Tape.** Furnish 4-inch-wide tape conforming to ASTM D 4592, Type I (removable).

**(b) Raised Pavement Markers.** Furnish an L-shaped polyurethane marker body with retroreflective tape on both faces of the vertical section, capable of retroreflecting light from opposite directions, and with an adhesive on the base.

Provide a minimum coefficient of retroreflection of 1200 candela/foot-candle/ft<sup>2</sup> at 0.1° observation angle and – 4° entrance angle.

Fabricate the marker body from polyurethane with a 60-mil minimum thickness. Fabricate the vertical leg about 2 inches high by about 4 inches wide. Fabricate the base for the marker body about 1 1/4 inches wide.

Factory apply a 125-mil minimum thickness and 750-mil-wide pressure-sensitive adhesive to the marker base and protect it with release paper.

If approved, variations in design and dimensions will be permitted in order to meet manufacturer’s standards.

### 718.25 Temporary Traffic Control Devices

Furnish traffic control devices (barricades, cones, tubular markers, vertical panels, drums, portable barriers, warning lights, advance warning arrow panels, traffic control signals, and so forth) whose designs and configurations conform to the MUTCD.

Use suitable commercial-grade material for the fabrication of the temporary traffic control devices. Construct the devices from material that is capable of withstanding anticipated weather and traffic conditions and is suitable for the intended use. Do not use units that have been used on other projects without approval.

When interpreting the requirements in the applicable MUTCD sections, replace the word “should” with the word “shall.”

### 718.26 Epoxy Resin Adhesives

Furnish epoxy resin adhesives for bonding traffic markers to hardened Portland cement and asphalt concrete that conform to AASHTO M 237.

## Section 720 - Structural Wall & Stabilized Embankment Material

### 720.01 Mechanically Stabilized Earth Wall Material

**(a) Concrete Face Panels.** Fabricate the panels in accordance with Section 552, except for the following:

- (1) Furnish Portland cement concrete that conforms to Class A (AE) and has a minimum 4,000 psi, 28-day compressive strength.
- (2) In addition to meeting the requirements specified in Subsection 562.11 for removal of forms and falsework, fully support the units until the concrete reaches a minimum compressive strength of 1,000 psi. The units may be shipped and/or installed after the concrete reaches a minimum compressive strength of 3,400 psi.
- (3) Finish the front face of the concrete panel surface with a Class 1 finish, in accordance with Subsection 552.18. Give the rear face a uniform surface finish. Screed the rear face of the panel to eliminate open pockets of aggregate and surface distortions in excess of ¼ inch. Cast the panels on a flat area. Do not attach galvanized connecting devices or fasteners to the face panel reinforcement steel.
- (4) Clearly scribe on an unexposed face of each panel the date of manufacture, production lot number, and piece mark.
- (5) Handle, store, and ship all units in a way that eliminates any danger of chipping, discoloration, cracks, fractures, and excessive bending stresses. Support panels in storage on firm blocking to protect the panel connection devices and the exposed exterior finish.
- (6) Manufacture all units within the following tolerances:
  - (a) For panel dimensions, ensure that the position of panel connection devices is within 1 inch, and that all other dimensions are within 3/16 inch.
  - (b) For panel squareness, as determined by the difference between the two diagonals, do not exceed 1/2 inch.
  - (c) For panel surface finish, do not permit surface defects on smooth formed surfaces 5 feet or more in length to exceed 1/8 inch. Do not permit surface defects on textured-finished surfaces 5 feet or more in length to exceed 1/8 inch.

Concrete face panels with any or all of the following defects will be rejected:

- Defects that indicate imperfect molding.
- Defects that indicate honeycombed or open texture concrete.

- Cracked or severely chipped panels.
- Color variation on front face of panel due to excess form oil or for other reasons.

**(b) Wire Facing.** Fabricate wire facing from W6 x W2 welded wire fabric conforming to AASHTO M 55, but ensure that the average shear value is not be less than 65,000 psi. After fabrication, galvanize the wire mesh in accordance with AASHTO M 111.

**(c) Backing Mat.** Fabricate backing mat from W1.7 x W1.7 (minimum) welded wire fabric conforming to AASHTO M 55. After fabrication, galvanize the backing mat in accordance with AASHTO M 111.

**(d) Clevis Connector.** Fabricate clevis connectors from cold-drawn steel wire conforming to AASHTO M 32 and welded in accordance with AASHTO M 55. After fabrication, galvanize clevis connectors in accordance with AASHTO M 111.

**(e) Connector Bars.** Fabricate the connector bars from cold-drawn steel wire conforming to AASHTO M 32. Galvanize the bars in accordance with AASHTO M 111.

**(f) Fasteners.** Furnish ½-inch-diameter heavy hexhead bolts, nuts, and washers conforming to AASHTO M 164. Galvanize the fasteners in accordance with AASHTO M 232.

**(g) Hardware Cloth.** Fabricate hardware cloth with maximum ¼-inch square mesh openings from woven steel wire fabric conforming to ASTM A 740. After fabrication, galvanize the cloth in accordance with AASHTO M 111.

**(h) Reinforcing Mesh.** Fabricate the reinforcing mesh from cold-drawn steel wire conforming to AASHTO M 32. Weld the mesh into the finished mesh fabric in accordance with AASHTO M 55. After fabrication, galvanize the reinforcing mesh in accordance with AASHTO M 111. Repair any damage to the galvanized coating before installation.

**(i) Reinforcing Strips.** Fabricate reinforcing strips from HSLA structural steel conforming to AASHTO M 223, Grade 65, Type 3. After fabrication, galvanize in accordance with AASHTO M 111.

**(j) Tie Strip.** Fabricate tie strips from hot rolled steel conforming to ASTM A 570, Grade 50. Galvanize in accordance with AASHTO M 111.

## 720.02 Gabion Material

**(a) Basket Mesh.** Twist or weld the mesh from galvanized steel wire, Class 3, soft temper, conforming to ASTM A 641 Class 3, or from aluminized steel wire, soft temper, conforming to ASTM A 809. Use wire with a minimum tensile strength of 60,000 psi when tested in accordance with ASTM A 370. The zinc or aluminum coating shall be applied after the mesh fabrication has been welded.

Fabricate baskets from either twisted wire mesh or welded wire mesh. Make the mesh openings with a maximum dimension of less than 4 3/4 inches and an area of less than 10 square inches. Furnish baskets in the dimensions required with a dimension tolerance of  $\pm 5$  percent.

Where the length of the basket exceeds one and one-half times its width, equally divide the basket into cells less than or equal to the basket width using diaphragms of the same type and size mesh as the basket panels. Prefabricate each basket with the necessary panels and diaphragms secured so they rotate into place.

**(1) Gabion Baskets 1 foot or Greater in the Vertical Dimension.** Fabricate the mesh for galvanized or aluminized coated gabions from wire with a diameter of 1/8-inch or greater in nominal size, and fabricate the mesh for epoxy or PVC-coated gabions from wire with a diameter of 1/8-inch or greater in nominal size.

*(a) Twisted Wire Mesh.* Form the mesh in a uniform hexagonal pattern with nonraveling double twists. Tie the perimeter edges of the mesh for each panel to a selvedge wire with a diameter of 1/8-inch or greater, or a selvedge wire with a diameter of 1/8-inch or greater for epoxy- or PVC-coated gabions, so that the selvedge is at least the same strength as the body of the mesh. Furnish selvedge wire from the same kind and type of material used for the wire mesh.

*(b) Welded Wire Mesh.* For mesh from wire with a diameter of 1/8 inch or greater in nominal size, weld each connection to obtain a minimum average weld shear strength of 585 pounds, with no value less than 450 pounds. For mesh for epoxy or PVC coated gabions from wire with a diameter of 1/8 inch in nominal size, weld each connection to obtain a minimum average weld shear strength of 472 pounds, with no value less than 360 pounds.

**(2) Gabion Mattresses.** Fabricate the mesh from wire with a diameter of 1/8 inch or greater in nominal size.

*(a) Twisted Wire Mesh.* Form the mesh in a uniform hexagonal pattern with nonraveling double twists. Tie the perimeter edges of the mesh for each panel to a selvedge wire with a diameter of 1/8 inch or greater so that the selvedge is at least the same strength as the body of the mesh. Furnish selvedge wire from the same kind and type of material used for the wire mesh.

*(b) Welded Wire Mesh.* Weld each connection to obtain a minimum average weld shear strength of 292 pounds, with no value less than 225 pounds.

**(3) PVC-Coated Gabions.** Use either the fusion bonding or extrusion coating process to coat the galvanized or aluminized mesh.

Make the coating at least 0.015 inches in thickness. For PVC coating, make the color black or gray and conform to the following:

- (a) Specific gravity, ASTM D 792 .....1.20 to 1.40
- (b) Tensile strength, ASTM D 638 .....2,300 psi min.
- (c) Modulus of elasticity, ASTM D 638 .....2,000 psi min. at  
100% strain
- (d) Hardness - shore "A," ASTM D 2240 .....75 min.
- (e) Brittleness temperature, ASTM D 746 .....16 °F max.
- (f) Abrasion resistance, ASTM D 1242,  
method B, at 200 cycles,  
CSI-A abrader tape, 80 grit .....12% max. weight loss
- (g) Salt spray (ASTM B 117) and .....No visual effect  
ultraviolet light exposure  
(ASTM D 1499 and G 23 using  
apparatus Type E and 145 °F  
for 3,000 h) (1)  $\Delta < 6\%$   
(2)  $\Delta < 25\%$   
(3)  $\Delta < 25\%$   
(6)  $\Delta < 10\%$
- (h) Mandrel bend, 360° bend at 0 °F around a  
mandrel 10 times the wire diameter .....No breaks or  
cracks in coating

**(b) Fasteners.** For lacing wire, use wire with a diameter of 1/16 inch in nominal size and that is of the same type, strength, and coating as the basket mesh.

For welded wire mesh panels, form the spiral binders with wire that has at least the same thickness, strength, and coating as the basket mesh.

Furnish alternate fasteners that are acceptable to the gabion manufacturer and that remain closed when subjected to a 585 pounds tensile force when confining the maximum number of wires to be confined. Submit installation procedures and fastener test results.

**(c) Internal Connecting Wire.** Use lacing wire as described in Subsection 720.02(b) to reinforce side panels. Alternate stiffeners that are acceptable to the gabion manufacturer may also be used.

### 720.03 Metal Bin Type Crib Walls

Fabricate members of the type and kind of material SHOWN ON THE DRAWINGS.

Conform to the following:

- (a) Galvanized steel sheets .....AASHTO M 218
- (b) Aluminum sheets .....AASHTO M 197
- (c) Fiber-bonded steel sheets .....707.09
- (d) Aluminum-coated steel sheets.....AASHTO M 274
- (e) Bolts and nuts .....ASTM A 307,  
Grade A

Furnish heavy hexagon heads and nuts without washers, or hexagon heads and nuts with two plate washers. Fabricate washers from 1/8 inch-thick round steel plate, including coating with holes not more than 5/8 inches larger than the bolt diameter. Galvanize the bolts, nuts, and washers in accordance with AASHTO M 232.

## Section 722 - Anchor Material

### 722.01 Ground Anchors

Furnish material for ground anchors in accordance with the specifications shown below.

**(a) Tendons.** Furnish ground anchor tendons for either single or multiple elements that conform to one of the following:

- (1) Steel strand uncoated seven-wire stress relieved for prestressed concrete .....AASHTO M 203
- (2) Uncoated high-strength steel bar for prestressed concrete .....AASHTO M 275
- (3) Steel strand uncoated seven-wire compacted stress relieved<sup>1</sup> for prestressing concrete .....ASTM A 779

<sup>1</sup> Ensure that elements also conform to the minimum requirements of AASHTO M 203.

**(b) Couplers.** Furnish couplers for tendon sections that are capable of developing 95 percent of the minimum specified ultimate tensile strength of the tendon.

**(c) Sheathing.** Furnish sheathing of the tendon in accordance with one of the following:

**(1) Unbonded Length.** For unbonded length, meet the following requirements:

*(a) Polyethylene Tube.* Furnish polyethylene of Type II, III, or IV, as defined by ASTM D 1248. Furnish tubing with a minimum wall thickness of 60 mil.

*(b) Hot-Melt Extruded Polypropylene Tube.* Furnish polypropylene with cell classification PP 210 B5554211, as defined by ASTM D 4101. Furnish tubing with a minimum wall thickness of 60 mil.

*(c) Hot-Melt Extruded Polyethylene Tube.* Furnish polyethylene of high-density Type III, as defined by ASTM D 3350 and D 1248. Furnish tubing with a minimum wall thickness of 60 mil.

*(d) Steel Tubing.* Furnish tubing that conforms to ASTM A 500 and has a minimum wall thickness of 3/16 inches.

*(e) Steel Pipe.* Furnish pipe that conforms to ASTM A 53, schedule 40, minimum.

*(f) Plastic Pipe.* Furnish pipe that conforms to ASTM D 1785, schedule 40, minimum.

**(2) Bonded Length.** For bonded length, meet the following requirements:

(a) *High-Density Corrugated Polyethylene Tubing.* Furnish tubing that conforms to AASHTO M 252 and has a minimum wall thickness of 30-mil.

(b) *Corrugated PVC Tubes.* Furnish PVC compounds that conform to ASTM D 1784, Class 13464–B.

(c) *Fusion-Bonded Epoxy.* Furnish epoxy that conforms to AASHTO M 284 and has a minimum film thickness of 15-mil.

**(d) Grease.** Furnish grease that is compounded to provide corrosion-inhibiting and lubricating properties, and that conforms to the PTI “Post Tensioning Manual,” Table 3.2.1.

**(e) Grout.** Furnish grout that consists of a pumpable mixture of Portland cement, sand, water, and admixtures mixed in accordance with Subsection 701.03. Use Type I, II, or III Portland cement in accordance with Subsection 701.01.

Chemical additives that can control bleed or retard set may be used, provided that the additives conform to Subsection 711.03 and are mixed in accordance with the manufacturer’s recommendations.

Furnish grout that is capable of reaching a cube strength (AASHTO T 106) of 3,600 psi in 7 days. Make grout cubes for testing from random batches of grout, as directed. Normally, strength testing will not be required, because system performance will be measured by proof-testing each anchor. Grout cube testing will be required if admixtures are used or irregularities occur in anchor testing.

**(f) Centralizers.** Centralizers and spacers may be fabricated from any type of material except wood that is not deleterious to the prestressing steel.

**(g) Anchorage Devices.** Furnish anchorage devices that conform to the PTI’s “Post Tensioning Manual,” Section 3.2.3. Furnish anchorage devices for strand tendons that are designed to permit lift-off testing without the jack engaging the strand. Furnish bearing plate for anchorage devices that is steel plate conforming to AASHTO M 183 or M 222.

Ensure that a pipe or trumpet extends from the anchor plate far enough to encapsulate the protective sheath. Furnish anchorage devices that are capable of developing 95 percent of the minimum specified ultimate tensile strength of the anchor tendon.

**Section 723 - Dust Palliative Materials**

**723.01 Magnesium or Calcium Chloride Brine**

Furnish chloride brines consisting of water and magnesium and/or calcium chloride with the following chemical composition (percent by weight brine):

- (a) Chloride concentration (sum of magnesium and calcium chloride):<sup>1</sup>
  - (1) Magnesium chloride products .....28% min.  
    Calcium chloride products .....36% min.
  - (2) Sulfate .....4.3% max.
  - (3) Nitrate .....5.0% max.

<sup>1</sup> Use test method R1-412/C1 (available on request from USDA Forest Service, Regional Materials Engineering Center, P.O. Box 7669, Missoula, Montana 59807).

Ensure that the pH is between 4.5 and 10.0, and that the temperature of the material is 40 °F or above when applied. Provide certification and sampling in accordance with Subsection 723.04.

**723.02 Calcium Chloride Flake**

Furnish calcium chloride flake in accordance with the following:

- (a) Chemical composition (percent by weight):
  - (1) Calcium chloride (CaCl<sub>2</sub>)<sup>1</sup> .....77% min.
  - (2) Total alkali chlorides (as NaCl) ASTM E 449 .....3% max.
  - (3) Calcium hydroxide (Ca(OH)<sub>2</sub>) ASTM E 449 .....0.3% max.

<sup>1</sup> Use test method R1-412/C1 (available on request from USDA Forest Service, Regional Materials Engineering Center, P.O. Box 7669, Missoula, Montana 59807).

- (b) Particle size (percent passing screen) by AASHTO T 27:
  - (1) 3/8 inch screen .....100%
  - (2) No. 4 screen .....80 to 100%
  - (3) No. 30 screen.....0 to 5%
- (c) Certification and sampling .....723.04

**723.03 Lignin Sulfonate**

Furnish lignin sulfonate from the residue produced by the acid-sulfite pulping of wood. Ensure that its base cation is ammonium, calcium, or sodium, and supply it as a uniform mixture that is miscible with an equal weight of water and meets the following requirements:

(a) Undiluted lignin sulfonate:

- (1) pH, AASHTO T 200 .....4.5 min.
- (2) Viscosity at 77 °F, AASHTO T 202 .....20.5 poise max.
- (3) Total lignin solids concentration<sup>1</sup> .....48% min.

(b) Solids:

- (1) Lignin sulfonate .....50% min.
- (2) Reducing sugars .....25% max.

(c) Temperature during application .....40 °F to 140 °F

(d) Certification and sampling .....723.04

<sup>1</sup> Use test method R1-412/LS for total lignin solids concentration (available on request from USDA Forest Service, Regional Materials Engineering Center, P.O. Box 7669, Missoula, Montana 59807).

### **723.04 Certification & Sampling**

**(a) Certification With Shipments.** When each load of dust palliative is delivered, furnish the CO with one copy of the Bill of Lading and a fully executed Certificate of Compliance containing the applicable information shown in Figure 723-1. A separate Certificate of Compliance will not be required if the standard Bill of Lading contains the applicable information required on the certificate.

**(b) Sampling.** Sampling of dust palliative prior to any mixing with water may be required to validate certifications furnished by the Contractor. When sampling is directed by the Government, obtain the actual samples, and give the CO the opportunity to witness sampling. Construct all liquid delivery equipment to permit sampling in conformance with AASHTO T 40 sampling procedure.

CERTIFICATE OF COMPLIANCE			
Consignee:			
Transportation ID (Truck No., Etc):			
Product Concentration by Weight:			
Destination:			
Date:			
Magnesium Chloride:		%	
Calcium Chloride:		%	
Lignin Sulfonate:		%	
Net Weight Total Shipment:			
Net Gallons 60 °F:			
Product Specific Gravity at 60 °F:			
This shipment of: _____ identified above and covered by the Certificate of Compliance complies with Forest Service specifications applicable to Contract # _____			
MSDS Identification Code:			
Producer:	_____		
Signed by:	<div style="border-top: 1px solid black; width: 100%;"></div> <p style="text-align: center;">(Producer's Representative)</p>		

Figure 723-1. - Sample Certificate of Compliance.

## **Section 725 - Miscellaneous Material**

### **725.01 Water**

Do not use water from streams, lakes, ponds, or similar sources without prior approval. Use water that conforms to the specifications shown below.

**(a) Water for Mixing or Curing Cement Concrete, Mortar, or Grout.** Furnish water that conforms to AASHTO M 157. Potable water of known quality may be used without testing in accordance with AASHTO T 26. Potable water is defined as water that is safe for human consumption, as described by the public health authority with jurisdiction.

**(b) Water for Planting or Care of Vegetation.** Furnish water that is free of substances injurious to plant life, such as oils, acids, alkalies, and salts.

**(c) Water for Earthwork, Pavement Courses, Dust Control, & Incidental Construction.** Furnish water that is free of substances detrimental to the work.

### **725.02 Calcium Chloride & Sodium Chloride**

**(a) Calcium Chloride for Concrete.** Furnish material that conforms to ASTM D 98, Type L, for the concentration specified.

**(b) Sodium Chloride.** Furnish material that conforms to ASTM D 632, Type II, Grade 1.

### **725.03 Hydrated Lime**

**(a) Lime for Masonry.** Furnish hydrated lime that conforms to ASTM C 207, Type N.

**(b) Lime for Soil Stabilization & Paving.** Furnish hydrated lime or quicklime that conforms to AASHTO M 216.

### **725.04 Fly Ash**

Furnish fly ash and raw or calcined pozzolans that conform to AASHTO M 295.

### **725.05 Mineral Filler**

Furnish mineral filler that conforms to AASHTO M 17.

### **725.06 Precast Concrete Curbing**

Furnish units conforming to the lengths, shapes, and details SHOWN ON THE DRAWINGS, and to the following:

- (a) Concrete .....602
- (b) Reinforcing steel .....709.01

**725.07 Clay or Shale Brick**

Furnish clay or shale brick that conforms to one of the following:

- (a) Sewer brick .....ASTM C 32,  
Grade SM
- (b) Building brick .....ASTM C 62,  
Grade SW

**725.08 Concrete Brick**

Furnish concrete brick that conforms to ASTM C 55, Grade N-I.

**725.09 Concrete Masonry Blocks**

Furnish rectangular or segmented concrete masonry blocks. When required, form the block ends to provide an interlock at vertical joints. Furnish blocks that conform to the following:

- (a) Solid load-bearing blocks .....ASTM C 90
- (b) Hollow load-bearing blocks .....ASTM C 90
- (c) Nonload-bearing blocks.....ASTM C 129

**725.10 Cellular Concrete Blocks**

Furnish cellular concrete blocks that conform to ASTM C 90, normal weight; but use concrete that conforms to Section 602.

**725.11 Precast Concrete Units**

Cast the units in substantial permanent steel forms. Provide additional reinforcement as necessary to provide for handling the units. Use concrete that conforms to the following:

- (a) 28-day strength, AASHTO T 22 .....3,600 psi min.
- (b) Air content by volume, AASHTO T 152 .....5% min.

Cure the units in accordance with AASHTO M 170.

Cast a sufficient number of concrete cylinders from each unit to permit compression tests at 7, 14, and 28 days. Make at least three cylinders for each test. If the strength

requirement is met at 7 or 14 days, the units will be certified for use 14 days from date of casting.

Do not use precast concrete units when:

- Representative cylinders do not meet the strength requirement by 28 days.
- Air content tests do not meet 5 percent minimum.
- Cracks or honeycombed or patched areas are larger than 30 square inches.

Furnish precast reinforced concrete manhole risers and tops conforming to AASHTO M 199.

### **725.12 Frames, Grates, Covers, & Ladder Rungs**

Fabricate metal grates and covers to evenly bear on the frames. Correct bearing inaccuracies by machining. Assemble all units before shipment. Mark all pieces to facilitate reassembly at the installation site. Uniformly coat all castings with asphalt varnish or a commercial preservative in accordance with the manufacture's standard practice. Conform to the following:

- (a) Gray iron castings .....AASHTO M 105
- (b) Carbon steel castings .....AASHTO M 103
- (c) Structural steel .....AASHTO M 183
- (d) Galvanizing .....AASHTO M 111
- (e) Malleable iron castings.....ASTM A 47
- (f) Aluminum alloy ladder rung material .....ASTM B 221,  
alloy 6061-T6
- (g) Aluminum castings .....ASTM B 26,  
alloy 356.0-T6
- (h) Asphalt varnish .....FSS TT-V-51

### 725.13 Corrugated Metal Units

Furnish material that conforms to one of the following:

- (a) Steel corrugated units .....AASHTO M 36
- (b) Aluminum corrugated units .....AASHTO M 196
- (c) Bituminous-coated corrugated units .....AASHTO M 190,  
Type A
- (d) Polymer-precoated corrugated units .....AASHTO M 245,  
Grade 10/10
- (e) Fiber-bonded units .....707.09

### 725.14 Protective Coatings for Concrete

Furnish protective coatings for bridge decks, curbs, sidewalks, and concrete portions of bridge railings. Provide one of the following coatings:

**(a) Boiled Linseed Oil.** Furnish boiled linseed oil in accordance with ASTM D 260, Type I or II.

**(b) Petroleum Spirits (Mineral Spirits).** Furnish petroleum spirits (mineral spirits) in accordance with ASTM D 235.

### 725.15 PVC Pipe for Water Distribution Systems

Furnish material that conforms to the following for the designated sizes and strength schedules:

- (a) PVC pipe .....ASTM D  
1785
- (b) Solvent cement for pipe and fittings .....ASTM D  
2564

### 725.16 Polyethylene Pipe for Water Distribution Systems

Furnish material that conforms to ASTM D 2447 for the designated sizes and strength schedules.

### 725.17 Cast Iron Soil Pipe & Fittings

Furnish material that conforms to ASTM A 74, Class SV, for the designated sizes.

**725.18 Seamless Copper Water Tube & Fittings**

Furnish material that conforms to ASTM B 88, Type L, for the designated sizes.

**725.19 Plastic Lining**

Furnish a film with a thickness of 7 ± 1 mil that conforms to one of the following:

- (a) PVC plastic film .....ASTM 1593,  
Type II
- (b) Polyethylene plastic film .....ASTM D 2103,  
Type 02000

**725.20 Bentonite**

Furnish bentonite as sodium montmorillonite (sodium bentonite) in the form of a powder that meets the following requirements:

- (a) Ensure that colloid content by AASHTO T88 or ASTM D422 is 60 percent minimum.
- (b) Ensure that a sieve analysis in accordance with AASHTO T27 on a dry, unwashed, unpulverized sample yields the following:
  - (1) A minimum of 95 percent passing the No. 4 sieve.
  - (2) A minimum of 15 percent passing the No. 200 sieve.

**725.21 Epoxy Resin Adhesives**

Ensure that epoxy resin adhesives conform to AASHTO M 235.

**725.22 Spray Finish**

Furnish a commercial product that is specifically designed for color spraying concrete, and that consists of a pliolite resin base, fiberglass, perlite, mica additives, and durable tinting pigments capable of making a light gray color similar to the color of concrete containing 8 oz. of carbon black per bag of cement.

**725.23 Color Coating**

Furnish a semiopaque colored toner containing methyl methacrylateethyl acrylate copolymer resins or equivalent resins, solvents, and color toning pigments suspended in solution by a chemical suspension agent. Ensure that the color toning pigments consist of laminar silicates, titanium dioxide, and inorganic oxides. Furnish material that conforms to the following:

- (a) Weight per gallon, ASTM D 1475 .....8.3 lb min.
- (b) Solids by weight, ASTM D 2369 .....30% min.
- (c) Solids by volume .....21% min.
- (d) Drying time, ASTM D 1640 . .....30 min at 70 °F  
and 50% max.  
humidity
- (e) Color change, ASTM D 822, 1,000 h .....No appreciable  
change
- (f) Resistance to acids, alkalies, gasoline, .....Excellent  
and mineral spirits, ASTM D 543
- (g) Water vapor transmission from interior .....Transmittable  
concrete, ASTM D, ASTM D 1653
- (h) Exterior moisture absorption into the .....Reduces rate  
concrete surface pores, FSS TT–C–555
- (i) Oxidation over time .....None

#### **725.24 Explosives & Blasting Accessories**

For the transportation, handling, and storage of explosives, conform to 29 CFR, part 1926, subpart U.

Explosives and initiating devices include, but are not necessarily limited to, dynamite and other high explosives, slurries, water gels, emulsions, blasting agents, initiating explosives, detonators, and detonating cord.

#### **725.25 Mineral Slurry (Driller’s Mud)**

Furnish commercially available sodium bentonite or attapulgite in a potable water. Use a mineral grain size that will remain in suspension with sufficient viscosity and gel characteristics so the mixture is capable of transporting excavated material to a suitable screening system.

#### **725.26 Form Liner**

Furnish a high-quality product that attaches easily to the forming system. Install the form liner so it does not compress more than ¼ inches at a concrete pour rate of 750 pounds per square foot.

#### **725.27 Aluminum-Impregnated Caulking Compound**

Conform to FSS TT–C–598, Grade 1.