

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, 25 MPa.
 - (2) At 7 days, 40 MPa.
 - (3) After 28 days, 50 MPa.

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 5 °C to 30 °C. 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 4 MPa min.
- (2) Flow, FLH T 502 or ASTM C 939, conforming to the following:
 - (a) Time of efflux¹ 16 to 26 seconds

¹A 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 2 MPa min.
- (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 6.8 MPa min.
- (7) Compressive strength, AASHTO T 106, 28-day 27.5 MPa min.

(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, 10 mm 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 75-mm slump, is:

- 24-hour 35 MPa
- 7-day 60 MPa
- 28-day 70 MPa

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

Submerged in:	DF (%)
Water	98
5% CaCl ₂ 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 25 mm or more in depth and more than 25 mm in width; and where the mixing, placing, and curing temperatures may range from 5 °C to 30 °C.

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 25 MPa in 4 hours.

Section 702—Bituminous Material

702.01 Asphalt Cement

Ensure that asphalt cement conforms to AASHTO M 20 or M 226, AASHTO MP 1, or applicable State department of transportation specifications for asphalt materials for the grade specified. When modified asphalt cement is used, test it in accordance with AASHTO PP 5.

702.02 Cutback Asphalt

Ensure that cutback asphalt conforms to the following specifications:

- (a) Rapid-curing, AASHTO M 81.
- (b) Medium-curing, AASHTO M 82.
- (c) Slow-curing, ASTM D 2026.

702.03 Emulsified Asphalt

Ensure that anionic emulsified asphalt conforms to AASHTO M 140, and cationic emulsified asphalt to AASHTO M 208, except as specified below. When specified for tack coat, an equivalent anionic grade emulsion may be substituted for a cationic grade, and vice versa. Unless otherwise noted, test the emulsion in accordance with the procedures in AASHTO T 59.

(a) CRS–2 Emulsions. Ensure that CRS–2 emulsions conform to AASHTO M 208.

(b) CRS–1h & CRS–2h Emulsions. Ensure that CRS–1h and CRS–2h emulsions conform to the requirements of CRS–1 and CRS–2, respectively, except as follows:

- (1) Penetration, 25 °C, 100 g, 5-second 40 to 90 mm

(c) CMS–2 & CMS–2h Emulsions. Ensure that CMS–2 and CMS–2h emulsions conform to AASHTO M 208; but in table 1, revise the percent of oil distillate as follows:

- (1) Oil distillate, by volume of emulsion 5 to 12%

(d) Quick-Set Emulsions. Ensure that quick-set emulsions conform to the following:

- (1) Viscosity, Saybolt Furol at 25 °C 20 to 100 seconds
- (2) Residue by distillation 57% min.
- (3) Sieve test 0.10% max.
- (4) Tests on residue from distillation:
 - (a) Penetration, 25 °C, 100 g, 5-second, AASHTO T 49 40 to 100 mm
 - (b) Solubility in trichloroethylene, AASHTO T 44 97.5% min.
 - (c) Ductility, 25 °C, 50 mm per minute, AASHTO T 51 ... 40 mm min.

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

- (1) Viscosity, 50 °C, 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, 25 °C, 100 g, 5-second 90 to 200 mm
 - (b) Solubility in trichloroethylene 97.5% min.
 - (c) Torsional recovery, CAL TRANS test no. 332 18% min.
or toughness/tenacity N•m¹ 5.6/2.8 min.

¹ Benson Method of Toughness and Tenacity, Scott tester, mm-kg at 25 °C, 500 mm per minute pull. Tensionhead 22 mm 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.

Table 702-1.—Application temperatures, range (°C).

Type and Grade of Asphalt	Temperature Ranges (minimum–maximum)	
	Spraying Temperatures	Mixing Temperatures ^b
Cutback asphalt:		
MC-30	30–a	–
RC, MC, or SC-70	50–a	–
RC, MC, or SC-250	75–a	60–80 ^c
RC, MC, or SC-800	95–a	75–100 ^c
RC, MC, or SC-3000	110–a	80–115 ^c
Emulsified asphalt:		
RS-1	20–60	–
RS-2	50–85	–
MS-1	20–70	20–70
MS-2, -2h	–	20–70
HFMS-1, -2, -2h, -2s	20–70	10–70
SS-1, -1h; CSS-1, -1h	20–70 ^d	20–70
CRS-1, -1h	50–85	–
CRS-2, -2h, -2 modified	60–85	–
CMS-2, -2h	40–70	50–60
Asphalt cement, all grades	180 max.	180 max.

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.

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.

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 -10°C .

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 75- μ m 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 number 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	% by Weight Passing Standard Sieves (AASHTO T 11 and T 27)
75 mm	100
19 mm	50–90
4.75 mm	20–50
75 µm	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 4.75-mm sieve) consists of natural or crushed sand and fine mineral particles.

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

Sieve Size	% by Mass Passing Designated Sieve (AASHTO T 27 and T 11)				
	Grading Designation				
	A (Subbase)	B (Subbase)	C (Base)	D (Base)	E (Base)
63 mm	100	—	—	—	—
50 mm	97–100	100	100	—	—
37.5 mm	—	97–100	97–100	100	—
25 mm	65–79 (6)	—	—	97–100	100
19 mm	—	—	67–81 (6)	—	97–100
12.5 mm	45–59 (7)	—	—	—	—
9.5 mm	—	—	—	56–70 (7)	67–79 (6)
4.75 mm	28–42 (6)	40–60 (8)	33–47 (6)	39–53 (6)	47–59 (7)
425 μ m	9–17 (4)	—	10–19 (4)	12–21 (4)	12–21 (4)
75 μ m	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 (\pm) from TV are shown in parentheses.

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

Sieve Size	% by Mass Passing Designated Sieve (AASHTO T 27 and T 11)	
	Grading Designation	
	F	G
37.5 mm	100	—
25 mm	97–100	100
19 mm	76–89 (6)	97–100
9.5 mm	56–68 (6)	70–80 (6)
4.75 mm	43–53 (7)	51–63 (7)
1.18 mm	23–32 (6)	28–39 (6)
425 μ m	15–23 (5)	19–27 (5)
75 μ m	10–16 (4)	10–16 (4)

Note: Allowable deviations (\pm) from TV are shown in parentheses. If the plasticity index (PI) is greater than 0, the TV range for the 75- μ m sieve size is 6–12 (\pm 4).

(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

(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 75- μ m sieve is less than 12% 2 to 9
 - (b) If the percent passing the 75- μ m 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 25 mm 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.

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

Sieve Size	% by Weight Passing Designated Sieve (AASHTO T 27 and T 11)			
	Grading Designation			
	A	B	D	F
50 mm	—	—	—	—
37.5 mm	100	—	—	—
25 mm	97–100	100	—	—
19 mm	—	97–100	100	—
12.5 mm	—	76–88	97–100	—
9.5 mm	53–70	—	—	100
4.75 mm	40–52	49–59	57–69	33–47
2.36 mm	25–39	36–45	41–49	7–13
600 µm	12–22	20–28	22–30	—
300 µm	8–16	13–21	13–21	—
75 µm	3–8	3–7	3–8	2–4

(a) **Coarse Aggregate.** Coarse aggregate (aggregate retained on the 4.75-mm 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.

(b) Fine Aggregate. Fine aggregate (aggregate that passes a 4.75-mm 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.

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

Sieve Size	% by Weight Passing Designated Sieve (AASHTO T 27 and T 11)				
	Grading Designation				
	DA	DB	DC	DD	DE
50 mm	100	—	—	—	—
37.5 mm	95–100	100	—	—	—
25 mm	—	95–100	100	—	—
19 mm	60–80 (7)	—	95–100	100	—
12.5 mm	—	60–80 (7)	—	95–100	100
9.5 mm	—	—	60–80 (7)	—	95–100
4.75 mm	20–55 (7)	25–60 (7)	35–65 (7)	45–70 (7)	60–80 (7)
2.36 mm	10–40 (6)	15–45 (6)	20–50 (6)	25–55 (6)	35–65 (6)
300 μ m	2–16 (4)	3–18 (4)	3–20 (4)	5–20 (4)	6–25 (4)
75 μ m	0–5 (3)	1–7 (3)	2–8 (3)	2–9 (3)	2–10 (3)

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

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

Sieve Size	% by Weight Passing Designated Sieve (AASHTO T 27 and T 11)			
	Grading Designation			
	OA	OB	OC	OD
37.5 mm	100	—	—	—
25 mm	95–100	100	—	—
19 mm	—	95–100	100	—
12.5 mm	25–65 (7)	—	95–100	100
9.5 mm	—	20–55 (7)	35–40 (7)	85–100 (7)
4.75 mm	0–10 (5)	0–10 (5)	—	—
2.36 mm	0–5 (3)	0–5 (3)	3–7 (3)	—
1.18 mm	—	—	—	0–5 (3)
75 μ m	0–2 (1)	0–2 (1)	0–1 (1)	0–2 (1)

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

(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.

Table 703-7.—Aggregate gradation requirements for single- and multiple-course surface treatments.

Sieve Size	% by Weight Passing Designated Sieve (AASHTO T 27 and T 11)					
	Grading Designation					
	A	B	C	D	E	F
37.5 mm	100	—	—	—	—	—
25 mm	90–100	100	—	—	—	—
19 mm	0–35	90–100	100	—	—	—
12.5 mm	0–8	0–35	90–100	100	—	—
9.5 mm	—	0–12	0–35	85–100	100	100
4.75 mm	—	—	0–12	0–35	85–100	85–100
2.36 mm	—	—	—	0–8	0–23	—
75 µm	0–2	0–2	0–2	0–2	0–2	0–10

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 19M 1,100 kg/m³ min.
- (d) Coating and stripping of bitumen-aggregate
mixtures, AASHTO T 182¹ 95% min.
- (e) Fractured faces, FLH T 507 75% min.
- (f) Flakiness index, FLH 508 30 max.
- (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.

¹An approved chemical additive may be used to meet this requirement.

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

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.

Table 703-8.—Slurry seal aggregate gradation requirements and application rates.^a

Sieve Size	% by Weight Passing Designated Sieve (AASHTO T 27 and T 11)		
	Type of Slurry Seal		
	I	II	III
9.5 mm	—	100	100
4.75 mm	100	90–100	70–90
2.36 mm	90–100	65–90	45–70
1.18 mm	65–90	45–70	28–50
600 µm	40–65	30–50	19–34
300 µm	25–42	18–30	12–25
150 µm	15–30	10–21	7–18
75 µm	10–20	5–15	5–15
Application rate (kg/m ²)	3.3–5.5	5.5–8.2	≥ 8.2

a. Based on the dry weight of the aggregate.

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.

Table 703-9.—Choker aggregate gradation.

Sieve Size	% by Weight Passing Designated Sieve (AASHTO T 27 and T 11)
9.5 mm	100
4.75 mm	70–100
75 µm	0.0–5.0

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 9.5-mm 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, AASHOT 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 703-10.—Superpave requirements for 12.5-mm nominal size aggregate.

Sieve Size (mm)	Control Points		0.45 Chart Max. Density	Restricted Zone		Allowable Deviation ^b
				Min. Boundary	Max. Boundary	
19.00	—	100.0	100.0	—	—	—
12.50	100.0	90.0	82.8	—	—	—
9.50	—	—	73.2	—	—	—
4.75	—	—	53.6	—	—	— ^a
2.36	58.0	28.0	39.1	39.1	39.1	— ^a
1.18	—	—	28.6	25.6	31.6	—
0.60	—	—	21.1	19.1	23.1	— ^a
0.30	—	—	15.5	15.1	15.1	— ^a
0.15	—	—	11.3	—	—	—
0.075	10.0	2.0	8.3	—	—	— ^a

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

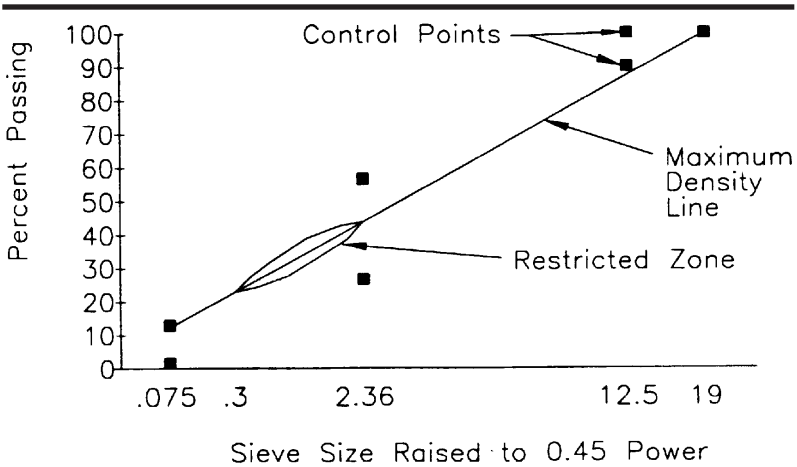


Figure 703-1.—Gradation chart for 12.5-mm nominal size aggregate.

Table 703-11.—Superpave requirements for 19-mm nominal size aggregate.

Sieve Size (mm)	Control Points		0.45 Chart Max. Density	Restricted Zone			Allowable Deviation ^b
				Min. Boundary	Max. Boundary	TV's	
25.00	—	100.0	100.0	—	—	—	—
19.00	100.0	90.0	88.4	—	—	—	—
12.50	—	—	73.2	—	—	—	—
9.50	—	—	64.7	—	—	—	—
4.75	—	—	47.4	—	—	— ^a	6
2.36	49.0	23.0	34.6	34.6	34.6	— ^a	6
1.18	—	—	25.3	22.3	28.3	—	—
0.60	—	—	18.7	16.7	20.7	— ^a	4
0.30	—	—	13.7	13.7	13.7	— ^a	3
0.15	—	—	10.0	—	—	—	—
0.075	8.0	2.0	7.3	—	—	— ^a	2

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

b. Plus or minus from established TV's.

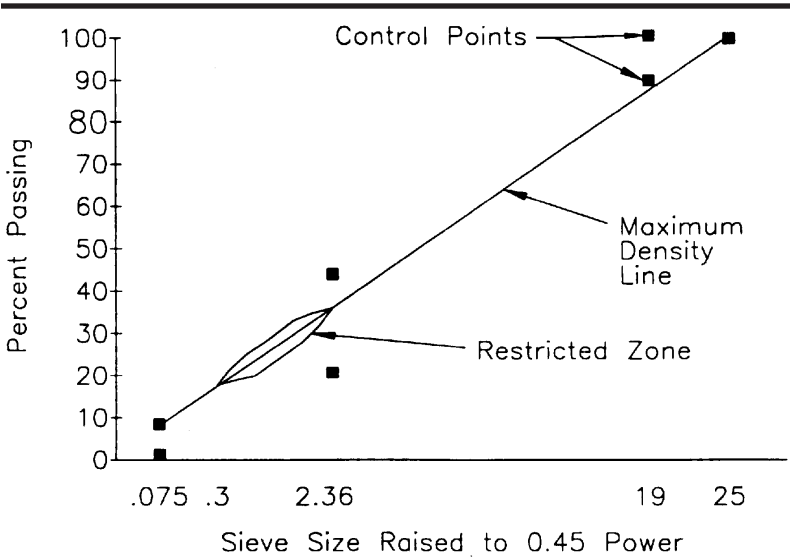


Figure 703-2.—Gradation chart for 19-mm nominal size aggregate.

Table 703-12.—Superpave requirements for 25-mm nominal size aggregate.

Sieve Size (mm)	Control Points		0.45 Chart Max. Density	Restricted Zone		Allowable TV's	Deviation ^b
				Min. Boundary	Max. Boundary		
37.5	—	100.0	100.0	—	—	—	—
25.0	100.0	90.0	83.3	—	—	—	—
19.00	—	—	73.6	—	—	—	—
12.50	—	—	61.0	—	—	—	—
9.50	—	—	53.9	—	—	—	—
4.75	—	—	39.5	39.5	39.5	— ^a	6
2.36	45.0	19.0	28.8	26.8	30.8	— ^a	6
1.18	—	—	21.1	18.1	24.1	—	—
0.60	—	—	15.6	13.6	17.6	— ^a	4
0.30	—	—	11.4	11.4	11.4	— ^a	3
0.15	—	—	8.3	—	—	—	—
0.075	7.0	1.0	6.1	—	—	— ^a	2

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

b. Plus or minus from established TV's.

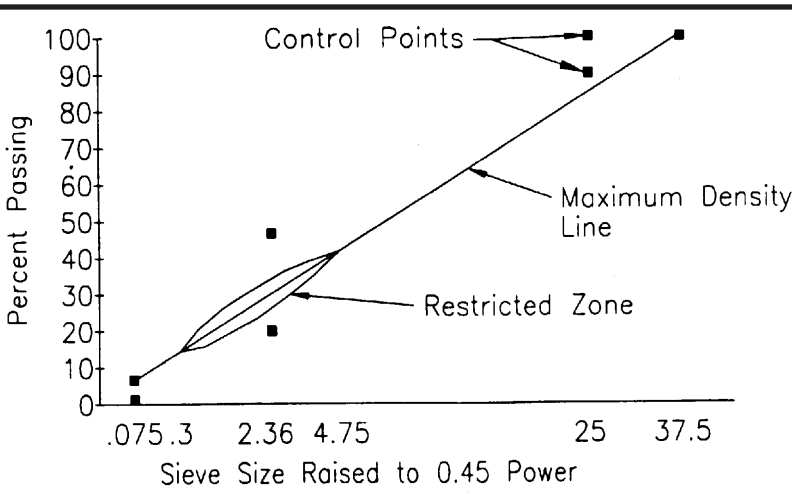


Figure 703-3.—Gradation chart for 25-mm nominal size aggregate.

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 50-mm sieve 100%
- (b) Soil classification, AASHTO M 145 A-1-a
- (c) In wet environments, material passing 75- μ m sieve ... 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 9.5-mm sieve 100%
- (2) Material passing 75- μ m 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 38 mm.

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 75 mm 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 75 mm in the longest dimension. Ensure that material conforms to the following:

- (a) Material passing 75- μ m 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 100 mm 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 600 mm 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	% by Weight Passing Designated Sieve (AASHTO T 27 and T 11)
75 mm	100
25 mm	70–100
4.75 mm	30–70
150 μ m	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	% by Weight Passing Designated Sieve (AASHTO T 27 and T 11)
75 mm	100
75 μ m	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	% by Weight Passing Designated Sieve (AASHTO T 27 and T 11)
12.5 mm	100
75.0 μ m	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 236¹ 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.

¹ 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.

Table 704-4.—Select granular backfill gradation.

Sieve Size	% by Weight Passing Designated Sieve (AASHTO T 27 and T 11)
100 mm	100
75 mm	75–100
75 µm	0–15

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

- (1) Resistivity, AASHTO T 288, any method 3,000 Ω x centimeter min.
- (2) pH, AASHTO T 289, any method 5.0 to 10.0
- (3) Sulfate content, AASHTO T 290, any method¹ 1,000 ppm max.
- (4) Chloride content, AASHTO T 291, any method¹ 200 ppm max.

¹ 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 Ω x centimeter

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 1,900 kg/m³ min.

Table 704-5.—Crib wall backfill gradation.

Sieve Size	% by Weight Passing Designated Sieve (AASHTO T 27 and T 11)
75 mm	100
4.75 mm	25–70
300 µm	5–20
75 µm	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 1,600 kg/m³ min.
- (c) Gradation:
 - (1) Baskets 0.3 m or greater in the vertical dimension:
 - (a) Max. dimension 200 mm
 - (b) Min. dimension 100 mm
 - (2) Baskets less than 0.3 m in the vertical dimension:
 - (a) Max. dimension 150 mm
 - (b) Min. dimension 75 mm

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

Table 705-1.—Gradation requirements for riprap.

Class	% of Rock by Mass	Mass (kg)	Approximate Cubic Dimension ^{b,c} (mm)
1	20	10–15	150–200
	30	5–10	125–150
	40	0.5–5	50–125
	10 ^a	0–0.5	0–50
2	20	25–50	200–250
	30	10–25	150–200
	40	1–10	75–150
	10 ^a	0–1	0–75
3	20	100–150	350–400
	30	50–100	250–350
	40	5–50	125–250
	10 ^a	0–5	0–125
4	20	250–350	450–500
	30	100–250	350–450
	40	10–100	150–350
	10 ^a	0–10	0–150
5	20	700–1,000	650–700
	30	350–700	500–650
	40	25–350	200–500
	10 ^a	0–25	0–200
6	20	850–1,600	700–850
	30	500–850	550–700
	40	50–500	250–550
	10 ^a	0–50	0–250

a. Furnish spalls and rock fragments graded to provide a stable compact mass.

b. The volume of a rock with these cubic dimensions will have a mass approximately equal to the specified rock mass.

c. Furnish stone with breadth and thickness at least one-third its length.

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.

(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 125 mm
- (2) Min. width 300 mm 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 300 mm.

Ensure that at least 50 percent of the total volume of masonry consists of rock with a volume of at least 0.03 m³.

(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 40 mm
- (2) Class B masonry 20 mm
- (3) Class A masonry 5 mm
- (4) Dimensioned masonry Reasonably true

(c) Bed Surfaces. Bed surfaces of face rock normal to the faces of the rocks for 75 mm. Beyond that point, do not permit the departure from normal to exceed 25 mm in 300 mm for dimensioned masonry, and 50 mm in 300 mm 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 50 mm. Beyond that point, do not permit the departure from normal to exceed 25 mm in 300 mm.

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

- (1) Cement rubble masonry 40 mm
- (2) Class B masonry 25 mm
- (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 75 mm. Beyond that point, the departure from the radial or normal may not exceed 20 mm in 300 mm.

Dress the back surface adjacent to the arch barrel concrete parallel to the front face and normal to the intrados to a depth of 150 mm. When concrete is placed after the masonry is constructed, vary adjacent ring stones at least 150 mm 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 10 mm apart with surface variations not to exceed 3 mm from the pitch line.

(2) Medium Pointed (M.P.). The point depressions are approximately 15 mm apart with surface variations not to exceed 5 mm from the pitch line.

(3) Coarse Pointed (C.P.). The point depressions are approximately 30 mm apart with surface variations not to exceed 10 mm 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 20 mm 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 “40 R.F.” is specified, do not permit projections beyond the pitch line to exceed 40 mm. 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.

% of Rock Fragments by Mass	Mass (kg)	Equivalent Cubic Dimension (mm)
50	> 900	> 700
50	40–900	250–700

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.

% of Rock Fragments by Mass	Mass (kg)	Equivalent Cubic Dimension (mm)
75	> 75	> 300
25	40–75	250–300

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 6 mm. 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 25 mm horizontal to 75 mm 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 25 mm 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 13 mm 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 100 mm 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 1.2 m, 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 13 mm. On other exposed faces, limit the maximum allowable projection or depression to 25 mm.
- (2) For unexposed surfaces, limit the maximum allowable projection or depression from a true plane on a 0.5-m length to 75 mm.
- (3) On exposed faces between adjacent segments of slope stone curb, limit the maximum allowable space that shows to 19 mm. Ensure that the minimum length of any segment of slope stone curb is 0.5 m.

Section 706—Concrete & Plastic Pipe

706.01 Nonreinforced Concrete Pipe

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

706.02 Reinforced Concrete Pipe

Furnish pipe that conforms to AASHTO M 170M 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 175M, type 1 or type 2, and to AASHTO M 86M for the diameters and strength classes specified.

706.04 Reinforced Arch-Shaped Concrete Pipe

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

706.05 Reinforced Elliptical-Shaped Concrete Pipe

Furnish pipe that conforms to AASHTO M 207M 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 242M for the diameters specified.

706.07 Precast Reinforced Concrete Box Sections

Furnish sections that conform to AASHTO M 259M or M 273M, 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 300- to 1,050-mm-diameter pipe conforming to ASTM F 714 and minimum cell class, ASTM D 3350, 335434C.
- (b) **Corrugated Polyethylene Pipe.** Furnish 300- to 900-mm-diameter pipe conforming to AASHTO M 294 and minimum cell class, ASTM D 3350, 315412C or 324420C.
- (c) **Profile Wall (Ribbed) Polyethylene Pipe.** Furnish 450- to 1,200-mm-diameter pipe conforming to ASTM F 894 and minimum cell class, ASTM D 3350, 334433C or 335434C.
- (d) **Corrugated Polyethylene Drainage Tubing.** Furnish 75- to 250-mm-diameter tubing conforming to AASHTO M 252.
- (e) **Smooth Wall PVC Pipe.** Furnish 100 to 375-mm-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 100- to 1,200-mm-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 36M and AASHTO M 218, M 274, or M 289 for the dimensions and thicknesses specified.

Fabricate underdrain pipe from a minimum of 1.32-mm steel sheets. Use any class of perforation specified in AASHTO M 36M.

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 196M for the sectional dimensions and thicknesses specified.

Fabricate underdrain pipe from a minimum of 1.22-mm 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 167M 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 219M 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 245M and M 246M. 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 36M 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 570 M, grade 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 36M, 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 196M, 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 36M 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) coatings 520 g/L
- (2) Other coatings 350 g/L

(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 20 °C.

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 Kerb 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 400 bars conforming to AASHTO M 31M, M 42M, or M 53M.

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

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 400 bars conforming to AASHTO M 31M or M 42M, except do not use AASHTO M 42M steel for tie bars bent and restraightened during construction.

(e) **Hook Bolts.** Furnish plain, grade 400 bars conforming to AASHTO M 31M or M 42M with M14 rolled threads or M16 cut threads. Furnish a threaded sleeve nut capable of sustaining a minimum axial load of 67 kN.

(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 $50 \text{ mm} \pm 5 \text{ mm}$ of the dowel, has a closed end, and has a suitable stop to hold the closed end 25 mm 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 6 mm tolerance vertically and horizontally during concrete placement and permit unrestricted movement of the pavement slab.

Use wire conforming to AASHTO M 32M 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 225M.

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

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

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

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

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

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 204M, type BA or WA.

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

(c) High-strength steel bars, AASHTO M 275M, 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 4.5 mm, conforms to ASTM A 641M, and has hard temper with a class 3 galvanized coating or an aluminized coating with a minimum coating weight of 120 g/m² 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 Redcedar 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 222M
- (2) Rail elements ASTM A 606, type 4
- (3) Fasteners AASHTO M 164M,
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 150 × 250-mm timber rail and the 100 × 225-mm blockouts from dry, well-seasoned, and dressed

rough-sawn Douglas Fir, Southern Pine, or other species with a stress grade of at least 10 MPa.

Treat the timber rail and blockout elements with CCA, ACZA, or ACA preservative treatment conforming to AWWA C14, but ensure that the minimum retention is 9.6 kg/m³.

Fabricate the steel backing elements from 9.5-mm structural steel conforming to AASHTO M 222M. Furnish fastener hardware that conforms to ASTM A 325M, 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 250 × 300-mm 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 75 mm 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 4-mm aluminum or galvanized steel sheets. Use adhesive that resists peeling with a force of 0.89 kg/cm 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 1,200 mm min.
- (b) Mesh openings 80 to 85 mm
- (c) Color International orange
- (d) Mass 0.25 kg/m min.

710.12 Crash Cushion Barrels

Furnish 900-mm-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 0.15 to 0.25 µm avg.

Section 711

- (e) Emulsion stabilizers Anionic and nonionic surfactant
- (f) Solids 46.5 to 49.0%
- (g) Mass 1.00 to 1.02 kg/L
- (h) pH 9 to 13
- (i) Shelf life 2 years min.