

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 construction¹ AASHTO M 153
- (4) Preformed expansion joint fillers for concrete paving and structural construction (nonextruding and resilient bituminous types) AASHTO M 213

¹ 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 10 MPa, 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 1.5 mm. 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 (MPa)	D 412	10	12	—
Elongation (%)	D 412	440	230	280
Tear resistance	D 624 (Die B)	40	20	—
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 70 kPa.

(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 8 mm max.
- (2) Extrusion rate, MIL-S-8802 75 to 250 g/min
- (3) Tack-free time, MIL-S-8802 20 to 75 minutes
- (4) Specific gravity, ASTM D 792, method A 1.010 to 1.515
- (5) Durometer hardness, shore A, ASTM D 2240 10 to 25
- (6) Tensile stress at 150% elongation, ASTM D 412 520 kPa max.
- (7) Elongation, ASTM D 412 500% min.
- (8) Peel (adhesion), MIL-S-8802 ≥ 9 kg with
 $\geq 75\%$ cohesive failure
- (9) Age from manufacturing 6 months max.

(g) Backer Rod. Furnish a closed-cell polyethylene conforming to ASTM D 3204, type 1. Use a compatible sealant as recommended by the manufacturer of the rod. Select size as shown in table 712-2.

Table 712-2.—Backer rod sizes.

Joint Width	Rod Diameter
8 mm	9 mm
9 mm	13 mm
13 mm	16 mm
16 mm	19 mm
19 mm	25 mm
25 mm	32 mm
32 mm	38 mm
38 mm	50 mm

712.02 Joint Mortar

Furnish Portland cement and fine aggregate conforming to Subsections 701.01 and 703.01, respectively. Mix one part Portland cement and two parts approved sand, with water as necessary to obtain a usable consistency. Use the mortar within 30 minutes after mixing.

712.03 Watertight Gaskets

For ring gaskets for rigid pipe, conform to AASHTO M 198, type A or B. For ring gaskets for flexible metal pipe, conform to ASTM C 361M. For continuous flat gaskets for flexible metal pipe with bands or bands with projections, conform to ASTM D 1056, grade SCE 41, and use a gasket with a thickness 13 mm greater than the nominal depth of the pipe corrugations. For continuous flat gaskets for flexible metal pipe with corrugated bands, conform to ASTM D 1056, grade SCE 43, and use a 9-mm-thick gasket.

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 14 MPa 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 138M, 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), 3021¹ 60 to 70
- (b) Compression set, 3311¹ 30% max.
- (c) Tensile strength, 4111¹ 17 MPa min.
- (d) Elongation at breaking, ASTM D 412 450% min.
- (e) Tensile stress, 300% elongation, 4131¹ 6 MPa min.
- (f) Water absorption by weight, 6631¹ 5% max.
- (g) Tensile strength after aging, 7111¹ 80% of original, min.

¹ 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 638M 9.6 MPa min.
- (b) Elongation at breaking, ASTM D 638M 250% min.
- (c) Hardness, ASTM D 2240 60 to 75 shore
- (d) Specific gravity, 5011¹ Manufacturer's value
± 0.02

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 25 mm, 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)
2 mm	90
425 μm	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 ± 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 ± 0.2 percent.
- (7) Air dried to a uniform weight of ± 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 12 mm max.
 - (b) Erosion control 25 mm 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 25 mm 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 1,000 g of water per 100 g of dry matrix.
- (3) Has no germination- or growth-inhibiting factors.
- (4) Forms no water-insensitive crust.
- (5) Contains material 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 mat.

Material	Specification Minimums
Straw ^a	240 g/m ²
Netting	Photodegradable netting on one side. 5- to 20-mm square mesh ^b with a 1.5 kg/100 m ² weight.

a. Moisture content shall not exceed 20 percent.

b. Dimensions are approximate and may vary to meet manufacturer's standards.

(b) *Burlap*. Furnish burlap fabric in a standard weave with a weight of 145 ± 20 g/m².

(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 25 × 25 mm max.

(2) Mesh weight, ASTM D 1776 0.5 kg/m² ± 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 3 to 6 mm

(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 16- to 25-mm square openings. Ensure that material conforms to the specifications shown in table 713-3.

Table 713-3.—Straw and coconut mat.

Material	Specification Minimums
Straw ^a 70%	240 g/m ²
Coconut 30%	240 g/m ²
Netting	Photodegradable netting on one side. 16- to 25-mm square mesh ^b with a 1.5 kg/100 m ² weight.

a. Moisture content shall not exceed 20 percent.

b. 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 ≥ 200 mm length 80% min.

(2) Mesh size 25 x 50 mm

(3) Blanket mass/area 0.53 ± 0.05 kg/m²

(c) *Mulch Blanket.* Furnish a 3- to 13-mm-thick 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 0.27 kg/m².

(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 16- to 25-mm square openings. Ensure that material conforms to the specifications shown in table 713-4.

Table 713-4.—Coconut erosion control mat.

Material	Specification Minimums
Coconut ^a	240 g/m ²
Netting	Photodegradable netting on one side. 16- to 25-mm square mesh ^b with a 1.5 kg/100 m ² weight.

a. Do not permit moisture content to exceed 20 percent.

b. Dimensions are approximate and may vary to meet manufacturer's standards.

(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.

(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 50 x 50-mm nominal mesh openings and weighing at least 8 g/m².

Table 713-5.—Synthetic erosion control mat.

Property	Specification	Test Method
Color	Green	Visual
Thickness	6 mm (min.)	ASTM D 1777
Strength ^a	1,590 x 525 N/m (min.)	ASTM D 5035
Elongation ^a	50% (max.)	ASTM D 5035
Porosity ^b	85% (min.)	Calculated
Resiliency ^c	80%	ASTM D 1777
Ultraviolet stability ^d	80%	ASTM D 4355

a. Values for both machine and cross-machine directions under dry or saturated conditions. Machine direction specimen for 50-mm strip test includes one machine-direction polyolefin stitch line centered within its width and extending the full length of the specimen.

b. Calculation based upon weight, thickness, and specific gravity.

c. The percent of original thickness retained after three cycles of a 690-kPa load for 60 seconds, followed by 60 seconds without load. Thickness measured 30 minutes after load removed.

d. 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	59 g/m ² (min.)	ASTM D 5261
Tensile strength	6,700 x 3,700 N/m	ASTM D 5035
Elongation at break	40% (max.)	ASTM D 5035
Mullen burst strength	515 kPa (min.)	ASTM D 3786

(d) *Organic Mulch Control Netting.* Furnish a leno weave mesh netting fabricated from 12.7-kg biodegradable cellulose fiber yarn with five twists per 25 mm. Make the size of the mesh grid 13 to 25 mm 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.

(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 300 mm 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.

Table 713-7.—Synthetic polypropylene erosion control mat.

Property	Specification	Test Method
Color	Black	Visual
Thickness	13 mm (min.)	ASTM D 1777
Tensile strength ^a	1,370 x 790 N/m	ASTM D 5035
Elongation ^a	50% (max.)	ASTM D 5035
Porosity ^b	90% (min.)	Calculated
Resiliency ^c	80%	ASTM D 1777
Ultraviolet stability ^d	80%	ASTM D 4355

a. Values for both machine and cross-machine directions under dry or saturated conditions using 50-mm strip method.

b. Calculation based upon weight, thickness, and specific gravity.

c. The percent of original thickness retained after three cycles of a 690-kPa load for 60 seconds, followed by 60 seconds without load. Thickness measured 30 minutes after load removed.

d. Tensile strength retained after 1,000 hours in a Xenon ARC weatherometer.

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)	0.009-0.013 mm	ASTM D 578
m/kg of rove	340-600 m/kg	ASTM D 578
km/kg of strand	2.62-2.82	ASTM D 578
Organic content, % max.	1.65	ASTM D 578

(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 713-9.—Polypropylene roving.

Property	Specification	Test Method
Tensile strength	15.6 N	ASTM D 2256
Elongation at break	15.5%	ASTM D 2256
Mass of strand	360 denier	ASTM D 1907
Strands per rove	24	Measured
Ultraviolet stability	50% retained after 200 h	ASTM D 4355

(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 amine 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 50 x 50 mm 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 25-mm-diameter garden or steam hose (rubber and fabric) to be used with wire for bracing and anchoring trees.

(c) **Wire.** Use 3.8-mm-diameter soft annealed galvanized steel wire for bracing and anchoring trees.

(d) **Wrapping Material.** Use 100-mm-wide rolls of waterproof paper (triple lamination 30–30–30) or 150-mm-wide rolls of burlap for wrapping trees.

(e) **Twine.** Use two-ply twine for trees 75 mm and less in diameter and three-ply twine for trees more than 75 mm 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 75 mm in height.

713.11 Pegs for Sod

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

- (a) Length 200 mm min.
- (b) Approximate cross-sectional area 600 mm²

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 ± 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 1 m
- (3) Shape Rectangular
- (4) Approximate mass 30 kg

(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 400 ∞ 450 ∞ 900 mm
- (2) Approximate mass 33 kg

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 0.01 m³ 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 75-mm-diameter wood or 1.86-kg/m steel fence posts.
- (b) **Supports.** Furnish 2.03-mm steel wire with a mesh spacing of 150 ∞ 150 mm 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 760 mm, and that minimum embedment depth is 150 mm.

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, style number, chemical composition of the filaments or yarn, and other pertinent information to fully describe the geotextile.

When samples are required, remove a 1-m-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.

Table 714-1.—Physical requirements for subsurface drainage geotextile.

Property	Test Method	Units	Specifications ^a					
			Type I-A	Type I-B	Type I-C	Type I-D	Type I-E	Type I-F
Grab strength	ASTM D 4632	N	1,100/700	1,100/700	1,100/700	800/500	800/500	800/500
Sewn seam strength	ASTM D 4632	N	990/630	990/630	990/630	720/450	720/450	720/450
Tear strength	ASTM D 4533	N	400 ^c /250	400 ^c /250	400 ^c /250	300/175	300/175	300/175
Puncture strength	ASTM D 4833	N	400/250	400/250	400/250	300/175	300/175	300/175
Burst strength	ASTM D 3786	kPa	2,700/1,300	2,700/1,300	2,700/1,300	2,100/950	2,100/950	2,100/950
Permittivity	ASTM D 4491	s ⁻¹	0.5	0.2	0.1	0.5	0.2	0.1
Apparent opening size	ASTM D 4751	mm	0.45 ^b	0.25 ^b	0.22 ^b	0.45 ^b	0.25 ^b	0.22 ^b
Ultraviolet stability	ASTM D 4355	%	50 ^d	50 ^d	50 ^d	50 ^d	50 ^d	50 ^d

a. 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).

b. Maximum average roll value.

c. The minimum average roll tear strength for woven monofilament geotextile is 245 N.

d. After 500 hours of exposure.

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

Property	Test Method	Units	Specifications ^a		
			Type IIA	Type IIB	Type IIC
Grab strength	ASTM D 4632	N	1,400/900	1,100/700	800/500
Sewn seam strength	ASTM D 4632	N	1,260/810	990/630	720/450
Tear strength	ASTM D 4533	N	500/350	400 ^c /250	300/180
Puncture strength	ASTM D 4833	N	500/350	400/250	300/180
Burst strength	ASTM D 3786	kPa	3,500/1,700	2,750/1,300	2,100/950
Permittivity	ASTM D 4491	s ⁻¹	0.02	0.02	0.02
Apparent opening size	ASTM D 4751	mm	0.60 ^b	0.60 ^b	0.60 ^b
Ultraviolet stability	ASTM D 4355	%	50 ^d	50 ^d	50 ^d

a. 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).

b. Maximum average roll value.

c. The minimum average tear strength for woven monofilament geotextile is 245 N.

d. After 500 hours of exposure.

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

Property	Test Method	Units	Specifications ^a	
			Type IIA	Type IIB
Grab strength	ASTM D 4632	N	1,400/900	1,100/700
Sewn seam strength	ASTM D 4632	N	1,260/810	990/630
Tear strength	ASTM D 4533	N	500/350	400 ^c /250
Puncture strength	ASTM D 4833	N	500/350	400/250
Burst strength	ASTM D 3786	kPa	3,500/1,700	2,750/1,300
Permittivity	ASTM D 4491	s ⁻¹	0.05	0.05
Apparent opening size	ASTM D 4751	mm	0.43 ^b	0.43 ^b
Ultraviolet stability	ASTM D 4355	%	50 ^d	50 ^d

a. 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).

b. Maximum average roll value.

c. The minimum average tear strength for woven monofilament geotextile is 245 N.

d. After 500 hours of exposure.

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

Property	Test Method	Units	Specifications ^a					
			Type IV-A	Type IV-B	Type IV-C	Type IV-D	Type IV-E	Type IV-F
Grab strength	ASTM D 4632	N	1,400/900	1,400/900	1,400/900	1,100/700	1,100/700	1,100/700
Sewn seam strength	ASTM D 4632	N	1,260/810	1,260/810	1,260/810	990/630	990/630	990/630
Tear strength	ASTM D 4533	N	500/350	500/350	500/350	400 ^c /250	400 ^c /250	400 ^c /250
Puncture strength	ASTM D 4833	N	500/350	500/350	500/350	400/250	400/250	400/250
Burst strength	ASTM D 3786	kPa	3,500/1,700	3,500/1,700	3,500/1,700	2,750/1,300	2,750/1,300	2,750/1,300
Permittivity	ASTM D 4491	s ⁻¹	0.7	0.2	0.1	0.7	0.2	0.1
Apparent opening size	ASTM D 4751	mm	0.43 ^b	0.25 ^b	0.22 ^b	0.43 ^b	0.25 ^b	0.22 ^b
Ultraviolet stability	ASTM D 4355	%	50 ^d	50 ^d	50 ^d	50 ^d	50 ^d	50 ^d

a. 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).

b. Maximum average roll value.

c. The minimum average roll tear strength for woven monofilament geotextile is 245 N.

d. After 500 hours of exposure.

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

Property	Test Method	Units	Specifications		
			Type V-A	Type V-B ^b	Type V-C ^c
Maximum post spacing	—	m	1.2	1.2	2
Grab strength:					
Machine direction	ASTM	N	400	550	550
Cross direction	D 4632	N	400	450	450
Permittivity	ASTM D 4491	s ⁻¹	0.05	0.05	0.05
Apparent opening size	ASTM D 4751	mm	0.60 ^a	0.60 ^a	0.60 ^a
Ultraviolet stability	ASTM D 4355	%	70 ^d	70 ^d	70 ^d

a. Maximum average roll value.

b. Elongation at break • 50 percent elongation (ASTM D 4632).

c. Elongation at break < 50 percent elongation (ASTM D 4632).

d. After 500 hours of exposure.

Table 714-6.—Physical requirements for paving fabric.

Property	Test Method	Units	Specifications
			Type VI
Grab strength	ASTM D 4632	N	500
Ultimate elongation	ASTM D 4632	N	50% at break
Asphalt retention	Texas DOT item 3099	L/m ²	0.90
Melting point	ASTM D 276	°C	150

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 cross-machine directions, provide sample sewn seams that are oriented in both the machine and cross-machine directions. Furnish a sewn sample that has a minimum 2 m of sewn seam and is at least 1.5 m 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.

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 275 kPa 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.

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 1-m-square sample from products supplied as sheets or panels, or a 1-m-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 0.1 L/s/m of width when tested in accordance with ASTM D 4716 under the following test conditions:

- (1) A specimen 300 mm long.
- (2) An applied load of 69 kPa.
- (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 0.1 liters per second per meter of width when tested in accordance with ASTM D 4716 under the following test conditions:

- (1) A specimen 300 mm long.
- (2) An applied load of 69 kPa.
- (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 a 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 3 liters per second per meter of width when tested in accordance with ASTM D 4716 under the following test conditions:

- (1) A specimen 300 mm long.
- (2) An applied load of 69 kPa.
- (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 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.

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 (kN/m)	Minimum Ultimate Strength at Breakage (kN/m)
1	9	13
2	13	21
3	17	29
4	28	61
5	53	98
6	70	125

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 22 to 75 mm. 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 3-m centers. In addition, place a strap at 75, 150, and 300 mm from the tip and two additional straps within 600 mm of the butt. Use 32-mm-wide x 0.8-mm-thick steel strapping material fabricated from cold-rolled, heat-treated, high-tensile steel with a minimum tensile strength of 22 kN.

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 57 x 0.9-mm-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 25-mm 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 25-mm 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 tar paper 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 25 mm from the face of the pile at any point.

Remove lifting anchors to a depth of at least 25 mm 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 15 °C, or 21 days at a minimum temperature of 4 °C. Do not transport or drive piles until cured for at least 21 days at a minimum of 15 °C, or 28 days at a minimum of 4 °C. 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 < 350 mm 6 mm
- Outside cylinder diameter ≥ 350 mm 10 mm
- Tapered or fluted 4.5 mm

(a) Shells Driven Without a Mandrel. For tapered or step-tapered cast-in-place concrete piles, furnish shells having a minimum 300-mm diameter at cutoff and a minimum 200-mm diameter at tip. For constant-diameter cast-in-place concrete piles, furnish shells having a minimum nominal diameter of 270 mm.

Fabricate the shells from not less than 4.5-mm plate stock conforming to AASHTO M 183M. 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 183M

- (c) Reinforced conical points for pipe closure at the tip... AASHTO M 103M
- (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 183M, 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 202M or AASHTO M 223M. 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 27M.

715.09 Splices

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

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 50 mm in width, including glued laminated members, before treatment. Treat glued laminated timbers in accordance with AWWA 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 270M and as shown below.

(a) Structural Carbon Steel. For primary bridge members, furnish structural carbon steel that conforms to AASHTO M 270M, grade 250T. For fracture-critical bridge members, furnish structural carbon steel that conforms to AASHTO M 270M, grade 250F. For other shapes, plates, and bars, furnish structural carbon steel that conforms to AASHTO M 270M, grade 250.

(b) High-Strength Low-Alloy (HSLA) Structural Steel. For other shapes, plates, and bars, furnish HSLA steel that conforms to AASHTO M 270M, grade 345 or 345W.

For primary bridge members, furnish HSLA steel that conforms to AASHTO M 270M, grade 345T or 345WT. Ensure that fracture-critical bridge members conform to AASHTO M 270M, grade 345F or 345WF.

For welded members, furnish HSLA steel that conforms to AASHTO M 270M, grade 345T or 345WT. Ensure that fracture-critical welded members conform to AASHTO M 270M, grade 345F or 345WF.

(c) High-Strength Quenched & Tempered Steel. For other shapes, plates, and bars, ensure that all quenched and tempered steel provided conforms to AASHTO M 270M, grade 485W, 690, or 690W. For primary bridge members, furnish quenched and tempered steel that conforms to AASHTO M 270M, grade 485WT, 690T, or 690WT. Furnish fracture-critical bridge members that conform to AASHTO M 270M, grade 485WF, 690F, or 690 WF.

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

(e) High-Strength Bolts, Nuts, & Washers. Conform to either AASHTO M 164M or AASHTO M 253M, 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 of 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 225 mm in diameter from annealed carbon-steel forgings that conform to AASHTO M 102, class C.

Furnish pins and rollers that are 225 mm 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 480 MPa and a yield point of 250 MPa.

Furnish pin threads that conform to the ANSI B1.1 Coarse Thread Series, class 2A. Thread pin ends with a diameter of 35 mm or more with six threads in 25 mm.

717.04 Castings

Furnish castings that conform to the following:

(a) Steel Castings. Furnish steel castings that conform to AASHTO M 192M, class 485.

(b) Chromium Alloy Steel Castings. Furnish chromium alloy steel castings that conform to AASHTO M 163M, 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 3, 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 $6 \text{ mm} \pm 1 \text{ mm}$, 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 270M, grade 250 or 345W. Ensure that steel furnished in accordance with AASHTO M 270M, grade 250, 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 $328 \text{ }^\circ\text{C} \pm 1 \text{ }^\circ\text{C}$.

(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 19 MPa
- (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.

Table 717-1.—TFE sheeting.

Property	ASTM Method	15% Glass Fibers	25% Carbon
Mechanical:			
Minimum tensile strength	D 1457	14 MPa	9 MPa
Minimum elongation	D 1457	150%	75%
Physical:			
Minimum specific gravity	D 792	2.20	2.10
Melting point	D 1457	327 °C ± 10 °C	327 °C ± 10 °C

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

(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 0.25-mm-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 25 µm thick.

(h) TFE Metal Composite. Furnish virgin TFE molded on each side and completely through a 33-mm 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 0.91 mm thick, conform to ASTM A 240, type 304, and have a surface finish

less than 0.5 µm 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.

Alloys Series	Specification	Wire
3xxx and 6xxx	AWS 5.10	ER 4043
3xxx, 5xxx, and 6xxx	AWS 5.10	ER 5356
5xxx and 6xxx	AWS 5.10	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 ASTM B 209	Drawn Formless Tubes ASTM B 210	Bars, Rods, and Wire ASTM B 211	Extruded Bars, Rods, Shapes, and Tubes ASTM B 221	Pipe ASTM B 241	Standard Structural Shapes ASTM B 308	Rivet Cold and Heading Wires and Rods ASTM B 316	Sand Castings ASTM B 26	Permanent Mold Castings ASTM B 108
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. ^{a, b}									
Aluminum, wrought			2024-T4 ^c						
Stainless steel			6061-T6 ^d						
Galvanized steel									
Aluminized steel									
Nuts, ^e wrought:					6061-T6 ^f				
6 mm and over ^b			2024-T4						
5 mm and under			6061-T6						
			6262-T9						

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

- Use compatible stainless or coated steel nuts and washers. Do not use aluminum for anchor bolts.
- Coat alloy 2024-T4 with a 5- μ m minimum thickness anodic coating with a dichromate or boiling water seal.
- Use alloy 2024-T4 for stress-carrying bolts and minor bolts.
- Use alloy 6061-T6 as an alternate material for minor bolts.
- Use with aluminum bolts and screws. Do not use aluminum for anchor bolt nuts and washers.
- ASTM B 211 is an acceptable alternate.

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

Railing Component	Sheet and Plate ASTM B 209	Drawn Formless Tubes ASTM B 210	Bars, Rods and Wire ASTM B 211	Extruded Bars, Rods, Shapes, and Tubes ASTM B 221	Pipe ASTM B 241	Standard Structural Shapes ASTM B 308	Rivet Cold and Heading Wires and Rods ASTM B 316	Sand Castings ASTM B 26	Permanent Mold Castings ASTM B 108
Washers, flat: ^b Wrought	Alclad 2024–T4 Alclad 2024–T3 ^c								
Washers, springlock: ^b Wrought			7075–T6						
Rivets: Wrought				6061–T6			6061–T6 ^{a,d} 6061–T4 ^{a,e}		
Shims: Wrought Cast	1100–0			6063–F ^a				443.0–F	
Weld filler: Wrought						5356			
End caps: Wrought Cast	6061–T6			6061–T6				356.0–T6 ^a 356.0–F 443.0–F	

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

a. Chemical, composition only.

b. Use with aluminum bolts and screws. Do not use aluminum for anchor bolt nuts and washers.

c. Use T3 temper for thicknesses less than 6 mm, and use T4 temper for thicknesses 6 mm and greater.

d. Use for cold-driven rivets.

e. Use for rivets driven at 530 °C to 565 °C.