Standard specifications for construction of roads and bridges on federal highway projects

Especificaciones estándar para la construcción de caminos y puentes en proyectos federales (FP-03) - Resumen

Autor: Departamento de Transporte de la Administración Federal de Autopistas de Estados Unidos
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Este documento fue elaborado por la Administración para formar parte de todos los pliegos contractuales para la construcción de caminos y puentes bajo su jurisdicción.

En la sección 713 se definen las características que deben cumplir todos los materiales que se utilicen para la adecuación de las banquinas. Se incluyen el suelo, las semillas, diferentes coberturas orgánicas, geosintéticos, etc.

En esta misma sección se provee una clasificación de los productos enrollables para el control de erosión, tanto temporarios como permanentes, según su resistencia al corte.

Traducción a español y resumen del documento "Standard specifications for construction of roads and bridges on federal highway projects", elaborado por el Departamento de Transporte de la Administración Federal de Autopistas de Estados Unidos. Realizados por Ing. Laura Martínez Quijano, Oficina Técnica – Coripa S.A. Buenos Aires, Argentina.
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STANDARD SPECIFICATIONS FOR CONSTRUCTION OF ROADS AND BRIDGES ON FEDERAL HIGHWAY PROJECTS

FP-03
Metric Units

U.S. Department
of Transportation

**Federal Highway
Administration**

**Federal
Lands Highway**

Publication No. FHWA-FLH-03-001

Standard Specifications for Construction of Roads and Bridges on Federal Highway Projects

FP-03

Metric Units

U.S. DEPARTMENT OF TRANSPORTATION
Federal Highway Administration

PREFACE

These Standard Specifications for the Construction of Roads and Bridges on Federal Highway Projects are issued primarily for constructing roads and bridges on Federal Highway projects under the direct administration of the Federal Highway Administration. These specifications are cited as "FP-03" indicating “Federal Project” Standard Specifications issued in 2003.

When designated in a contract, the FP-03 becomes part of the contract and binding upon all parties to the contract. All construction contracts of the Federal Highway Administration are also governed by the following regulations:

- Federal Acquisition Regulation (FAR), Title 48, Code of Federal Regulations, Chapter 1; and

- Transportation Acquisition Regulation (TAR), Title 48, Code of Federal Regulations, Chapter 12.

The FAR and TAR regulations are not included in the FP-03. A complete copy of the FAR is available from the Superintendent of Documents, Congressional Sales Office, U.S. Government Printing Office, Washington, DC 20402.

The International System of Units (SI) is used in the FP-03 as required by Public Law 100-418 (1988 Omnibus Trade and Competitiveness Act) and Executive Order 12770 (Metric Usage in Federal Government Programs).

SI[(1)] (METRIC) TO ENGLISH CONVERSION FACTORS (approximate)				
Symbol	**When You Know**	**Multiply By**	**To Find**	**Symbol**
		LENGTH		
µm	micrometers	3.9×10^{-5}	inches	in
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
		VOLUME		
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.31	cubic feet	ft^3
m^3	cubic meters	1.308	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg	megagrams	1.1023	short tons	T
(or "t")	(or "metric ton")		(2000 lb)	
		TEMPERATURE (exact)		
ºC	Celsius	1.8C +32	Fahrenheit	ºF
	temperature		temperature	
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/m^2	$caldela/m^2$	0.2919	foot-Lamberts	fl
		MISCELLANEOUS		
J	joule	0.7376	foot·poundforce	ft·lbf
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce	lbf/in^2
			per square inch	

(1) SI is the symbol for the International System of Units.
Appropriate rounding should be made to comply with Section 4 of ASTM E 380.

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Section 713. — ROADSIDE IMPROVEMENT MATERIAL

713.01 Topsoil.

(a) Furnished topsoil. Furnish fertile, friable, free draining, sandy loam soil that is free of subsoil, refuse, stumps, roots, brush, weeds, rocks larger than 25 millimeters, or other substances detrimental to the development of vegetative growth. Demonstrate that the soil can sustain healthy crops of grass, shrubs, or other plant growth. Conform 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. See Subsection 204.02(c).

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

Table 713-1
Agricultural Limestone Gradation

Sieve Size	Minimum Percent by Mass Passing Designated Sieve (AASHTO T 27)
2.00 mm	90
425 µm	50

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

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, mass, and guaranteed analysis of contents clearly marked.

Liquid fertilizer containing the minimum percentage of available nutrients may be used.

713.04 Seed. Conform to the Federal Seed Act, the Federal Noxious Weed Act, and applicable State and local seed and noxious weed laws. Do not use wet, moldy, or otherwise contaminated or damaged seed. Furnish each seed type in separate sealed container. Clearly label each container with the following:

(a) Name and type of seed;

(b) Lot number;

(c) Net mass;

(d) Percent of purity, germination, and hard seed;

(e) Percent of maximum weed seed content;

(f) Seed Origin;

(g) Noxious weeds present;

(h) Other crop seed;

(i) Inert matter;

(j) Name and address of seed distributor; and

(k) Mixture percent of each component.

Inoculate legume seed with approved cultures according to the manufacturer's instructions.

713.05 Mulch.

(a) Straw. Furnish certified weed free straw from oats, wheat, rye, or other grain crops that is free from mold or other objectionable material. Furnish straw in an air-dry condition suitable for placing with mulch blower equipment.

(b) Wood fiber. Furnish processed wood fiber from wood chips conforming to the following:

(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) Free of weed seed;

(6) Air dried to an equilibrium moisture content of 12±3 percent;

(7) Packaged in new labeled containers; and

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

(c) Grass straw cellulose fiber. Furnish processed grass straw fiber conforming to the following:

(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) Free of weed seed;

(6) Air dried to a moisture content of 10±0.2 percent;

(7) Air dried to a uniform mass of ±5 percent;

(8) Packaged in new containers labeled with the manufacturer's name and air-dry mass; and

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

(d) Peat moss. Furnish a granulated sphagnum peat moss conforming to the following:

(1) Sticks, stones, and mineral matter	0%
(2) Partially decomposed stems and leaves of sphagnum	75% min.
(3) Color	brown
(4) Textured from porous fibrous to spongy fibrous	
(5) pH	3.5 to 7.5

(6) Air-dried

(e) Mature compost. Furnish partially decomposed organic material, 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-free, and pathogen-free mature compost conforming to the following:

(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) Man-made inserts (plastic, glass, metal)	2% max.

(f) Straw for hydroseeding. Furnish clean agricultural straw milled to 25 millimeters or less in length. Dry the fibers to 10 percent moisture for compaction. Bale in heat-sealed plastic bags.

(g) Bonded fiber matrix hydromulch. Furnish a mixture of long-wood fibers and bonding agent which, when hydraulically applied and dried, produce a matrix conforming to the following:

(1) Does not dissolve or disperse when wetted;

(2) Holds at least 1000 grams of water per 100 grams 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; and

(6) Is colored with a green dye noninjurious to plant growth.

(h) Recycled pulp fiber. Furnish cellulose fiber mulch products manufactured from natural material diverted from the waste-stream of manufacturing processes or produced from recycled material. These include newsprint, chipboard, corrugated cardboard, wood chips, and similar material. Process the material to eliminate substances that inhibit seed germination and plant growth. Add a colored dye that is non-injurious to plant growth and fades rapidly with exposure to light. The fiber shall readily blend with water, grass seed, fertilizer, and other additives to for a slurry suitable for application with power spray equipment. Furnish a homogeneous mixture conforming to the following:

(1) Synthetic, plastic, metal, or glass material	0%
(2) Weed Seed	0%
(3) Moisture content	15% max.
(4) Ash content	7% max.
(5) Organic matter	90 min.
(6) Boron	250 ppm max.
(7) Water-holding capacity	800 to 1200% by mass
(8) pH	4.0 to 8.5

713.06 Plant Material. Conform to the *American Standard for Nursery Stock.*

(a) Quality of plant material. Furnish plants that are excellent representatives of their normal species or varieties. Furnish nursery grown stock that has been transplanted or root-trimmed two or more times according to the kind and size of plant. Furnish plants with a normally developed branch system. Do not furnish plants with disfiguring knots, sun-scald, injuries, abrasions of the bark, dead or dry wood, broken terminal growth, or other objectionable disfigurements.

Furnish trees with reasonably straight stems and well branched and symmetrical branches according to 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. 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 including Federal regulations governing interstate movement of nursery stock. Provide a valid copy of the certificate of inspection with each package, box, bale, or carload shipped or otherwise delivered.

(e) Balled and burlapped (B&B) plants. Furnish plants from the original and undisturbed soil in which the plants were grown. Dig B&B 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 Cellular Confinement Systems. Furnish a flexible honeycomb 3-dimensional structure fabricated from light stabilized polyethylene plastic. Conform to the following:

(a) Functional longevity	120 months min.
(b) Cell area	200 to 300 cm^2
(c) Sheet thickness, ASTM D 751	1.24 to 1.26 mm
(d) Density, ASTM D 792	0.941 to 0.960 g/cm^3
(e) Carbon black content, ASTM D 1603	1.5 to 2.5 %
(f) Environmental stress crack resistance, ASTM D 1693	2000 hours min.

(g) Conform to Table 713-2 for the depth specified.

Table 713-2
Cellular Confinement Systems

Property	**Specifications**				
Nominal cell depth	50 mm	75 mm	100 mm	150 mm	200 mm
Cell joint strength	500 N min.	700 N min.	1000 N min.	1400 N min.	2000 N min.

713.08 Miscellaneous Planting Material.

(a) Stakes for bracing and anchoring. Conform to the *American Lumber Standards.* Fabricate stakes for bracing and anchoring trees from rough cypress, cedar, locust, or other approved wood essentially free from knots, rot, crossgrain, or other defects that would impair the strength of the stake. Furnish stakes with a minimum 50 by 50-millimeter square cross-section and adequate length.

Furnish anchor stakes of the same size and quality as bracing stakes. The diameter and length of the deadman is specified in the contract.

(b) Hose. Furnish 25-millimeter diameter garden or steam hose (rubber and fabric) to be used with wire for bracing and anchoring trees.

(c) Wire. Furnish 3.8-millimeter diameter soft annealed galvanized steel wire for bracing and anchoring trees.

(d) Wrapping material. Furnish 100-millimeter wide rolls of waterproof paper (triple lamination 30-30-30) or 150-millimeter wide rolls of burlap for wrapping trees.

(e) Twine. Furnish 2-ply twine for trees 75 millimeters and less in diameter and 3-ply twine for trees over 75 millimeters in diameter for tying wrapping material to the trees.

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

(g) Tree wound dressing. Furnish a commercially available product with asphalt base and fungicide. Furnish material that is antiseptic, waterproof, adhesive, and elastic. Do not use material that is harmful to living tree tissue such as kerosene, coal tar, or creosote.

713.09 Reserved.

713.10 Sod. Furnish living vigorous sod of the type of grass and thickness specified in the contract. Furnish sod with a dense root system that is reasonably free from noxious weeds and grasses. Before taking up the sod, cut the top growth to less than 75-millimeter height.

713.11 Pegs for Sod. Furnish square or round pegs of sound wood and conform to the following:

(a) Length	200 mm min.
(b) Approximate cross-sectional area	600 mm^2

713.12 Stabilizing Emulsion Tackifiers. Furnish a commercially available product containing no solvents or other diluting agents toxic to plant life. Conform to one of the following:

(a) Emulsified asphalt grades SS-1, SS-1h, CSS-1, or CSS-1h;

(b) Nonasphalt emulsions having 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; and

(c) Polyvinyl acetate using emulsion resins and containing 60±1 percent total solids by mass.

713.13 Erosion Control Bales, Wattles, Logs, and Rolls.

(a) Straw bales. Furnish bales tied with either commercial quality baling wire or string. Conform to the following:

(1) Straw	Subsection 713.05(a)
(2) Approximate length	1 meter
(3) Shape	rectangular
(4) Approximate mass	30 kilograms

(b) Wood excelsior bales. Furnish bales of curled wood excelsior. Tie the bales with either a commercial bailing wire, plastic, or string. Conform to the following:

(1) Approximate dimensions	400 by 450 by 900 mm
(2) Approximate mass	33 kilograms

(c) Excelsior fiber wattles, logs or rolls. Furnish wattles, logs, or rolls of curled excelsior fiber rolled into a cylindrical shape and encased in a seamless photodegradable tubular netting. Conform to the following:

(1) Diameter	300 mm min.
(2) Mass	1.36 kg/300 mm min.

(d) Straw wattles, logs or rolls. Furnish straw wattles that are manufactured from weed free straw and wrapped in a tubular photodegradable plastic netting made from 85% high density polyethylene, 14% ethyl vinyl acetate and 1% color for UV inhibition. Conform to the following:

(1) Diameter	230 mm min.
(2) Netting strand thickness	0.75 mm
(3) Netting knot thickness	1.4 mm
(4) Mass of netting	29.3 to 35.8 g/m

713.14 Sandbags. Use clean, silt free material for sand filler. Conform to the following:

(a) Bag material	canvas or burlap
(b) Volume per bag	0.01 cubic meter 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 loading M18 on temporary culvert pipe placed beneath the traveled way.

713.16 Silt Fence. Conform to AASHTO M 288.

713.17 Temporary Rolled Erosion Control Products. Furnish temporary rolled erosion control products conforming to Table 713-3 and the following. See the Erosion Control Technology Council website (ECTC.org) for commercially available products that may conform to these specifications.

(a) Type 1.A, ultra-short term mulch control netting. Furnish a mulch control netting consisting of rapidly degrading photodegradable synthetic mesh or woven biodegradable natural fiber netting with a 3-month typical functional longevity designed for use on geotechnically stable slopes with gradients up to 1:5 and channels with shear stresses up to 12 pascals.

(b) Type 1.B, ultra-short term netless erosion control blanket. Furnish an erosion control blanket composed of processed rapidly degrading natural or polymer fibers mechanically interlocked or chemically adhered together to form a continuous matrix with a 3-month typical functional longevity designed for use on geotechnically stable slopes with gradients up to 1:4 and channels with shear stresses up to 24 pascals.

(c) Type 1.C, ultra-short term single-net erosion control blanket and open weave textile. Furnish one of the following materials: (1) an erosion control blanket composed of processed degradable natural or polymer fibers mechanically-bound together by a single rapidly degrading, synthetic or natural fiber netting to form a continuous matrix or (2) an open weave textile composed of processed rapidly degrading natural or polymer yarns or twines woven into a continuous matrix. The material must have a 3-month typical functional longevity and be designed for use on geotechnically stable slopes with gradients up to 1:3 and channels with shear stresses up to 72 pascals.

(d) Type 1.D, ultra-short term double-net erosion control blankets. Furnish an erosion control blanket composed of processed natural or polymer fibers mechanically-bound between two rapidly degrading, synthetic or natural fiber nettings to form a continuous matrix, with a 3-month typical functional longevity designed for use on geotechnically stable slopes with gradients up to 1:2 and channels with shear stresses up to 84 pascals.

(e) Type 2.A, short-term mulch control netting. Furnish a mulch control netting consisting of photodegradable synthetic mesh or woven biodegradable natural fiber netting with a 12-month typical functional longevity designed for use on geotechnically stable slopes up to 1:5 and channels with shear stresses up to 12 pascals.

(f) Type 2.B, short-term netless erosion control blanket. Furnish an erosion control blanket composed of processed degradable natural or polymer fibers mechanically-interlocked or chemically-adhered together to form a continuous matrix with a 12-month typical functional longevity designed for use on geotechnically stable slopes with gradients up to 1:4 and channels with shear stresses up to 24 pascals.

(g) Type 2.C, short-term single-net erosion control blanket or open weave textile. Furnish one of the following materials: (1) an erosion control blanket composed of processed degradable natural or polymer fibers mechanically-bound together by a single degradable synthetic or natural fiber netting to form a continuous matrix; or (2) an open weave textile composed of processed degradable natural or polymer yarns or twines woven into a continuous matrix. The material must have a 12-month typical functional longevity and be designed for use on geotechnically stable slopes with gradients up to 1:3 and channels with shear stresses up to 72 pascals.

(h) Type 2.D, short-term double-net erosion control blankets. Furnish an erosion control blanket composed of processed natural or polymer fibers mechanically bound between two natural fiber or synthetic nettings to form a continuous matrix with a 12-month typical functional longevity designed for use on geotechnically stable slopes with gradients up to 1:2 and channels with shear stresses up to 84 pascals.

(i) Type 3.A, extended term mulch control netting. Furnish a mulch control netting consisting of a slow degrading synthetic mesh or woven natural fiber netting with a 24-month typical functional longevity designed for use on geotechnically stable slopes with gradients up to 1:5 and channels with shear stresses up to 12 pascals.

(j) Type 3.B, extended term erosion control blanket or open weave textile. Furnish one of the following materials: (1) an erosion control blanket composed of processed slow degrading natural or polymer fibers mechanically-bound together between two slow degrading synthetic or natural fiber nettings to form a continuous matrix; or (2) an open weave textile composed of processed slow degrading natural or polymer yarns or twines woven into a continuous matrix. The material must have a 24-month typical functional longevity and be designed for use on geotechnically stable slopes with gradients up to 1:1.5 and channels with shear stresses up to 96 pascals.

(k) Type 4, long-term erosion control blanket or open weave textile. Furnish one of the following materials: (1) an erosion control blanket composed of processed slow degrading natural or polymer fibers mechanically-bound together between two slow degrading synthetic or natural fiber nettings to form a continuous matrix; or (2) an open weave textile composed of processed slow degrading natural or polymer yarns or twines woven into a continuous matrix. The material must have a 36-month typical functional longevity and be designed for use on geotechnically stable slopes with gradients up to 1:1 and channels with shear stresses up to 108 pascals.

Table 713-3
Temporary Rolled Erosion Control Products

Rolled Erosion Control Product Type												
Property	**1.A[1]**	**1.B**	**1.C**	**1.D**	**2.A [1]**	**2.B**	**2.C**	**2.D**	**3.A [1]**	**3.B**	**4**	**Test Method**
Typical functional longevity[2] (months)	3	3	3	3	12	12	12	12	24	24	36	N/A
Minimum tensile strength[3] (kN/m)	0.073	0.073	0.73	1.09	0.073	0.73	0.73	1.09	0.36	1.45	1.82	ASTM D 4595
Maximum "C" factor[4]	0.10 at 1:5	0.10 at 1:4	0.15 at 1:3	0.20 at 1:2	0.10 at 1:5	0.10 at 1:4	0.15 at 1:3	0.20 at 1:2	0.10 at 1:5	0.25 at 1:1.5	0.25 at 1:1	ASTM D6459 or other qualified independent test[7]
Minimum permissible shear stress[5][6] (Pa)	12	24	72	84	12	24	72	84	12	96	108	ASTM D6460 or other qualified independent test[7]

(1) Obtain max "C" factor and allowable shear stress for mulch control nettings with the netting used in conjunction with pre-applied mulch material.

(2) Functional longevities are for guidance only. Actual functional longevities may vary based on site and climatic conditions.

(3) Minimum average roll values, machine direction.

(4) "C" factor calculated as ratio of soil loss from rolled erosion control product protected slope (tested at specified or greater gradient, v:h) to ratio of soil loss from unprotected (control) plot in large-scale testing. These performance test values should be supported by periodic bench scale testing under similar test conditions and failure criteria using Erosion Control Technology Council (ECTC) Test Method #2).

(5) Minimum shear stress the rolled erosion control product (unvegetated) can sustain without physical damage or excess erosion (> 12.7-millimeter soil loss) during a 30-minute flow event in large-scale testing. These performance test values should be supported by periodic bench scale testing under similar test conditions and failure criteria using ECTC Test Method #3.

(6) The permissible shear stress levels established for each performance category are based on historical experience with products characterized by Manning's roughness coefficients in the range of 0.01 to 0.05.

(7) Other large scale test methods determined acceptable by the CO.

713.18 Permanent Rolled Erosion Control Products. Furnish permanent turf reinforcement mats conforming to Table 713-4 and the following. See the Erosion Control Technology Council website (ECTC.org) for commercially available products that may conform to these specifications.

(a) Type 5.A, permanent turf reinforcement mat. Furnish a non-degradable turf reinforcement mat with sufficient thickness, strength and void space for permanent erosion protection and vegetation reinforcement on geotechnically stable slopes with gradients up to 2:1, channels with design shear stresses up to 288 pascals, and other areas where design flow conditions exceed the limits of natural vegetation.

(b) Type 5.B, permanent turf reinforcement mat. Furnish a non-degradable turf reinforcement mat with sufficient thickness, strength and void space for permanent erosion protection and vegetation reinforcement on geotechnically stable slopes with gradients up to 2:1, channels with design shear stresses up to 384 pascals, and other areas where design flow conditions exceed the limits of natural vegetation.

(c) Type 5.C, permanent turf reinforcement mat. Furnish a non-degradable turf reinforcement mat with sufficient thickness, strength and void space for permanent erosion protection and void space for permanent erosion protection and vegetation reinforcement on geotechnically stable slopes up to 2:1, channels with design shear stresses up to 480 pascals, and other areas where design flow conditions exceed the limits of natural vegetation.

Table 713-4
Permanent Turf Reinforcement Mats

Properties[1]	Rolled Erosion Control Product Type			Test Method
	5.A	5.B	5.C	
Minimum tensile strength[2][3] (kilonewtons per meter)	1.82	2.19	2.55	ASTM D4595
UV stability (minimum % tensile retention)	80	80	80	ASTM D 4355 (500-hour exposure)
Minimum thickness[2] (millimeters)	6.35	6.35	6.35	ASTM D 6525
Minimum permissible shear stress[4] (pascals)	288	384	480	ASTM D 6460 or other qualified independent test[5]

(1) For turf reinforcement mats containing degradable components, obtain all property values on the non-degradable portion of the matting alone.
(2) Minimum average roll values, machine direction only.
(3) Field conditions with high loading and high survivability requirements may warrant the use of turf reinforcement mats with tensile strengths of 44 kilonewtons per meter or greater.
(4) Minimum shear stress the turf reinforcement mat (fully vegetated) can sustain without physical damage or excess erosion (>12.7-millimeter soil loss) during a 30-minute flow event in large-scale testing. These performance test values should be supported by periodic bench scale testing under similar test conditions and failure criteria using Erosion Control Technology Council Test Method #3.
(5) Other large-scale test methods determined acceptable by the CO.