SECTION 985
GEOSYNTHETIC MATERIALS

985-1 Description.

Geosynthetic materials are used for nonstructural and structural applications and shall be either geotextiles (woven or non-woven) or geogrids (woven or extruded) that are used for drainage, erosion control, reinforcement, separation or stabilization.

985-2 Materials.

985-2.1 General Requirements: Unless restricted in the Plans or Specifications, the geosynthetic material shall be a woven, non woven or extruded material consisting of long-chain polymeric filaments or yarns such as polypropylene, polyethylene, polyester, polyamides or polyvinylidene chloride formed into a stable network such that the filaments or yarns retain their relative position to each other. The base plastic shall contain stabilizers and/or inhibitors to make the filaments resistant to deterioration due to ultra-violet light, heat exposure and potential chemically damaging environment. The edges of the material shall be selvaged or otherwise finished to prevent the outer yarn from pulling away from the material and shall be free of any treatment which may significantly alter its physical properties.

985-2.2 Physical Requirements: Each geosynthetic material shall be tested by an independent third party in accordance with the following methods as they apply to the specific application type. All testing and reported values, except apparent opening size (AOS), are to be minimum average roll values in the weakest principle direction unless indicated otherwise in this Section. Values for AOS are maximum average roll values.

Geotextile Selection	
In-situ Soil Type~~s~~ or Drainage Application ~~% passing a No. 200 Sieve*~~	Class for Type D1, D2, D3 Materials (see Table 1.1)
< 15% passing a No. 200 Sieve*	a
15% to 50% passing a No. 200 Sieve*	b
> 50% passing a No. 200 Sieve*	c
> 50% passing a No. 200 Sieve*with Plastic Index >7	d
MSE Joint Cover for Sand Backfill	e
MSE Joint Cover for Coarse Aggregate or Limerock Backfill	f
*as per AASHTO T88.	

Table 1.1 Drainage Geotextiles Test Methods and Requirements for Types D-1, D-2 and D-3			
Property/Test Method	D-1	D-2	D-3
Minimum Permittivity (Sec - 1) per ASTM D4491	D-1a = 0.7 D-1b = 0.2 D-1c = 0.1 D-1d = 0.1 D-1e = 0.7 D-1f = 1.5	D-2a = 0.7 D-2b = 0.2 D-2c = 0.1 D-2d = 0.1 D-2e = 0.7 D-2f = 1.5	D-3a = 0.5 D-3b = 0.2 D-3c = 0.1 D-3d = 0.1 D-3e = 0.7
Maximum AOS (US Sieve No.*) per ASTM D4751	D-1a = 40 D-1b = 60 D-1c = 70 D-1d = 50 D-1e = 70 D-1f = 30	D-2a = 40 D-2b = 60 D-2c = 70 D-2d = 50 D-2e = 70 D-2f = 30	D-3a = 40 D-3b = 60 D-3c = 70 D-3d = 50 D-3e = 70
Minimum Grab Tensile Strength (lbs) per ASTM D4632	315	Woven Monofilament = 248 Other Woven Geotextiles: Elongation <50% = 315 Elongation >50% = 203	Elongation <50% = 248 Elongation ~~>~~≥50% = 158
~~Minimum Sewn Strength (lbs)~~Mass per Unit Area (oz/sy) per ASTM ~~D4632~~D5261	~~283~~Provide Test Result	~~Woven Monofilament=223 Other Woven Geotextiles: Elongation <50% = 283 Elongation >50% = 182~~Provide Test Result	~~Elongation <50% = 223 Elongation >50% = 142~~Provide Test Result
Minimum Puncture Strength (lbs) per ASTM D6241	618	Woven Monofilament = 495 Other Woven Geotextiles: Elongation <50% = 618 Elongation ~~>~~≥50% = 433	Elongation <50% = 495 Elongation ~~>~~≥50% = 309
Minimum Trapezoidal Tear (lbs) per ASTM D4533	113	Woven Monofilament = 57 Other Woven Geotextiles: Elongation <50% = 113 Elongation ~~>~~≥50% = 79	Woven Monofilament = 57 Other Geotextiles: Elongation <50% = 90 Elongation ~~>~~≥50% = 57
Minimum UV Resistance per ASTM D4355 (% Retained Strength)	50% @500 hours	50% @500 hours	50% @500 hours
Limitations	Woven	Woven Geotextiles only.	No Slit Film Geotextiles

Table 1.1 Drainage Geotextiles Test Methods and Requirements for Types D-1, D-2 and D-3			
Property/Test Method	D-1	D-2	D-3
	Monofilament Geotextiles only	No Slit Film Geotextiles allowed.	allowed.
*Equivalent opening sizes in millimeters per ASTM E11 are as follows: No. 30 sieve = 0.600, No. 40 sieve = 0.425, No. 50 sieve = 0.300, No. 60 sieve = 0.250, No. 70 sieve = 0.212			

Table 1.2 Test Methods and Requirements for Drainage Geotextiles Types D-4~~/6~~ and D-5		
Property/Test Method	D-4~~/6~~	D-5
Minimum Permittivity (Sec^{-1}) per ASTM D4491	0.5	0.5
Maximum AOS (US Sieve No.) per ASTM D4751	40	~~40~~70
Minimum Grab Tensile Strength (lbs) per ASTM D4632	180	~~180~~90
~~Minimum Sewn Strength (lbs)~~Mass per Unit Area (oz/sy) per ASTM ~~D4632~~D5261	~~162~~Provide Test Result	~~162~~Provide Test Result
Minimum Puncture Strength (lbs) per ASTM D6241	223	223
Minimum Trapezoidal Tear (lbs) per ASTM D4533	35	40
Minimum UV Resistance per ASTM D4355 (% Retained Strength)	50% @500 hours	50%@500 hours

Table 2 Test Methods and Requirements for Erosion Control Materials					
Property/Test Method	E-1	E-2	E-3	E-4	E-5
Permittivity (Sec^{-1}) per ASTM D4491	0.05	0.05			
Grab Tensile Strength (lbs) per ASTM D4632	90	90			
Minimum UV Resistance per ASTM D4355 (% Retained Strength)	80% @500 hours	80% @150 hours	80% @500 hours		
Wide Width Tensile Strength **(lbs/in) per ASTM D6818			11.4 x 5.7	22.8 x 11.4	45.7 x 22.8
Filtration Efficiency (%) per ASTM D5141	75% and min. flow rate of 0.3 gal/sf/min				
Design Shear***			≥2.1 psf	≥3.6 psf	≥5.0 psf
** Wide Width Tensile Strength is expressed in units of measure of lbs/in, in machine direction and cross direction as MD x CD. *** Design Shear limits for Erosion mats must be determined by 30 minutes sustained flow in an unvegetated state as determined by tests performed by Utah State University, Texas Transportation Institute or an independent testing laboratory approved by the State Drainage Engineer.					

Table 3 Test Methods and Requirements for Structural Geosynthetics			
Property/Test Method	Structural Application Type	Test Methods for Woven Geotextiles	Test Methods for Woven or Extruded Geogrids
Permittivity (sec^{-1})	R - 1, 2, 3, 4, 5	ASTM D4491	
UV Stability (Min Retained Strength @500 hr)	R - 3	ASTM D4355	ASTM D4355
Puncture Strength (lbs)	R - 5	ASTM D6241	
Grab Strength (lbs)	R - 5	ASTM D4632	
Opening Size	R - 1, 2, 3, 4, 5	AOS (US Sieve No.) ASTM D4751	Aperture Size (in x in)
Tensile Strength (lbs/ft)		ASTM D4595	ASTM D6637
Machine Direction Ultimate, (T_{ult})			
2% Strain	R - 1, 3		
5% Strain	R - 2, 3, 4, 5		
10% Strain	R - 1, 2, 3, 4, 5		
Cross Direction Ultimate			
2% Strain	R - 1, 2, 3, 4, 5		
5% Strain	R - 1, 2, 3, 4, 5		
10% Strain	R - 1, 2, 3, 4, 5		
Strain @ Ultimate Tensile Strength	R - 1, 2, 3, 4, 5		
Tear Strength (lbs)		ASTM D4533	
Machine Direction	R - 5		
Cross Direction	R - 5		
Soil-Geosynthetic Friction	R - 1, 2, 3	ASTM D6706	ASTM D6706
Creep Resistance-T_{creep} (lbs/ft)	R - 2, 3, 4	ASTM D5262	ASTM D5262
Creep Reduction Factor (T_{ult}/T_{creep})	R - 2, 3, 4		
Installation Damage (RF_{ID})		~~GRI: GT7~~AASHTO R69	~~GRI: GG4(a) & GG4(b)~~ AASHTO R69
Sand	R - 2, 3, 4		
Limestone	R - 2, 3, 4		
Durability (RF_{ID})			
Chemical	R - 2, 3, 4	~~GRI: GT7~~ AASHTO R69	~~GRI: GG4(a) & GG4(b)~~ AASHTO R69
Biological	R - 2, 3, 4	~~GRI: GT7~~	~~GRI:~~

Table 3 Test Methods and Requirements for Structural Geosynthetics			
Property/Test Method	Structural Application Type	Test Methods for Woven Geotextiles	Test Methods for Woven or Extruded Geogrids
		AASHTO R69	~~GG4(a) & GG4(b)~~ AASHTO R69
Joint Strength (RF_j)			
Mechanical	R - 2, 3	GRI: GT7	GRI: GG4(a) & GG4(b)
Sewn	R - 2, 3	ASTM D4884	

985-2.3 Overlaps and Seams: Overlaps shall be in accordance with the manufacturer's recommendations unless specified otherwise in the Contract Documents for a particular application. To reduce overlaps, the geosynthetic material may be sewn together in accordance with the manufacturer's recommendations. Sew the seams with thread meeting the chemical requirements and minimum seam strength requirements in Tables 1.1, 1.2 and 3.

985-2.4 Packaging and Labeling: Geosynthetics shall be packaged in a protective covering sufficient to protect the material from temperatures greater than 140 F, sunlight, dirt, and other debris during shipment and storage. The manufacturer's name, product name, style number, roll dimensions and LOT numbers must be clearly labeled on all packaging.

985-3 Product Acceptance and Certification.

985-3.1 Product Acceptance: All geosynthetic materials shall be one of the products listed on the Department's Approved Product List (APL). Manufacturers seeking evaluation of products must submit an application in accordance with Section 6 and include independently certified test reports that the material meets the physical requirements of this Section. Products will be listed on the APL according to geosynthetic application type. For products with limited APL approvals, installations and design alternatives must not rely on the limitation. Structural geosynthetics are listed with property values.

985-3.2 Certification: The Contractor shall submit to the Engineer a certification from the manufacturer confirming that the material meets the requirements of this Section and is appropriate for the intended use. The manufacturer shall also provide two 8 inch by 10 inch samples of the geosynthetic material for product identification. The manufacturer's certification shall be attested to by a person having legal authority to bind the manufacturing company.

The manufacturer shall maintain test records as required by this Specification and these records shall be made available to the Department upon request.

985-4 Applications.

985-4.1 Nonstructural:

985-4.1.1 Drainage: Select geotextile materials that meet the required permeability and AOS based on test results on the soil or fill adjacent to the geotextile for gradation. Materials for drainage applications must be tested in accordance with and meet the physical requirements in 985-2.2, Table 1.1.

Drainage Applications		
Geotextile Type	Description	Design Standards Index No.
D-1	Revetment (Special)	
	Rock, Rubble without bedding stone	
	Ditch Pavement (Rubble Riprap) without bedding stone	281
D-2	Revetment (Standard)	
	Articulating Block	
	Gabions	281
	Rock, Rubble, and Broken Concrete with bedding stone	
	Ditch Pavement (Rubble Riprap) with bedding stone	281
	Joint Cover for Mechanically Stabilized Retaining Wall Supporting Spread Footing Foundations	
D-3	Underdrain	286
	French Drain	285
	Sheet Piling Filter	
	Filter Fabric Jacket (Culvert)	280
	Concrete Pavement Subdrainage	287
	Joint Cover for Mechanically Stabilized Retaining Wall	
D-4~~/6~~	Slope Pavement	
	Ditch Pavement (Sand-Cement Riprap or Concrete)	281
D-5	~~Mechanically Stabilized Retaining Wall (Joint Cover)~~ Separation Geotextile	~~548~~
	Cast-In-Place Retaining Wall	

985-4.1.2 Erosion Control: Materials used for erosion control applications must be tested in accordance with and meet the physical requirements in 985-2.2, Table 2.

Erosion Control Applications	
Type	Description
E-1	Staked Silt Fence
E-2	Wind Screen
E-3	Plastic Erosion Mat (Turf Reinforcement Mat) (Type 1)
E-4	Plastic Erosion Mat (Turf Reinforcement Mat) (Type 2)
E-5	Plastic Erosion Mat (Turf Reinforcement Mat) (Type 3)

985-4.2 Structural:

985-4.2.1 Reinforcement, Separation and Stabilization: Materials for reinforcement, separation and stabilization applications must be tested in accordance with and meet the physical requirements in 985-2.2, Table 3.

Reinforcement, Separation and Stabilization Applications

Reinforcement, Separation and Stabilization Applications	
Type	Description
R-1	Geosynthetic Reinforced Soil (GRS)
R-2	Reinforcement of Foundations over Soft Soils
R-3	Steepened Slopes
R-4	Reinforced Embankment
R-5	Construction Expedient