Migration of Geosynthetic Indices to ~~QPL~~ APL

2014 Design Training Expo

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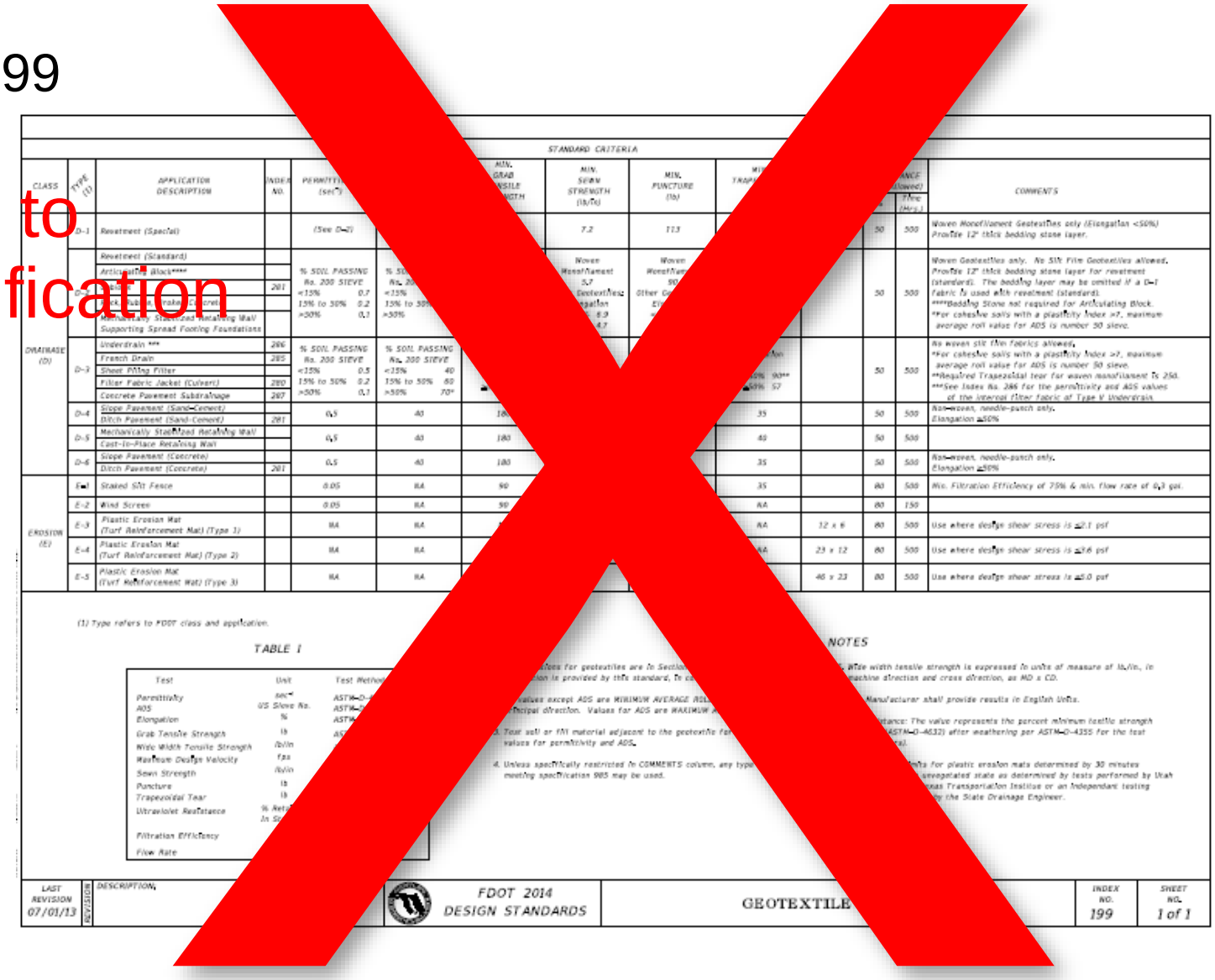
Outline

- Geosynthetics Standard Indices
- Specification 985 & APL
- Benefit to Manufacturers
- Benefit to Construction
- Impacts on Design

Geosynthetics Design Indices

- Index 199
- Move to Specification 985



STANDARD CRITERIA

CLASS	TYPE (1)	APPLICATION DESCRIPTION	INDEX NO.	PERMITTIVITY (sec⁻¹)		MIN. GRAB TENSILE STRENGTH	MIN. SEAM STRENGTH (lb/in)	MIN. PUNCTURE (lb)	MIN. TRAP				COMMENTS
												Flow (Hrs.)	
	D-1	Revetment (Special)		(See D-2)			7.2	113			50	500	Woven Monofilament Geotextiles only (Elongation <50%) Provide 12" thick bedding stone layer.
	D-2	Revetment (Standard)					Woven Monofilament 5.7 Geotextiles: Elongation 6.9 4.7	Woven Monofilam 90 Other G Elo			50	500	Woven Geotextiles only. No Silt Film Geotextiles allowed. Provide 12" thick bedding stone layer for revetment (standard). The bedding layer may be omitted if a D-1 fabric is used with revetment (standard). ****Bedding Stone not required for Articulating Block. *For cohesive soils with a plasticity index >7, maximum average roll value for AOS is number 50 sieve.
		Articulating Block****	281	% SOIL PASSING No. 200 SIEVE <15% 0.7 15% to 50% 0.2 >50% 0.1	% SOIL PASSING No. 200 SIEVE <15% 15% to 50% >50%								
		Articulated Concrete Block Revetment											
		Mechanically Stabilized Retaining Wall Supporting Spread Footing Foundations											
DRAINAGE (D)	D-3	Underdrain ***	286	% SOIL PASSING No. 200 SIEVE <15% 0.5 15% to 50% 0.2 >50% 0.1	% SOIL PASSING No. 200 SIEVE <15% 40 15% to 50% 60 >50% 70*				Non 50% 90** 50% 57		50	500	No woven silt film fabrics allowed. **For cohesive soils with a plasticity index >7, maximum average roll value for AOS is number 50 sieve. **Required Trapezoidal tear for woven monofilament Tc 250. ***See Index No. 286 for the permittivity and AOS values of the internal filter fabric of Type V Underdrain.
		French Drain	285										
		Sheet Piling Filter											
		Filter Fabric Jacket (Culvert)	280										
		Concrete Pavement Subdrainage	287										
	D-4	Slope Pavement (Sand-Cement) Ditch Pavement (Sand-Cement)	281	0.5	40	16			35		50	500	Non-woven, needle-punch only. Elongation ≥50%
	D-5	Mechanically Stabilized Retaining Wall		0.5	40	180			40		50	500	
		Cast-In-Place Retaining Wall											
	D-6	Slope Pavement (Concrete) Ditch Pavement (Concrete)	281	0.5	40	180			35		50	500	Non-woven, needle-punch only. Elongation ≥50%
EROSION (E)	E-1	Staked Silt Fence		0.05	NA	90			35		80	500	Min. Filtration Efficiency of 75% & min. flow rate of 0.3 gal.
	E-2	Wind Screen		0.05	NA	90			NA		80	150	
	E-3	Plastic Erosion Mat (Turf Reinforcement Mat) (Type 1)		NA	NA				NA	12 x 6	80	500	Use where design shear stress is ≥2.1 psf
	E-4	Plastic Erosion Mat (Turf Reinforcement Mat) (Type 2)		NA	NA				NA	23 x 12	80	500	Use where design shear stress is ≥3.6 psf
	E-5	Plastic Erosion Mat (Turf Reinforcement Mat) (Type 3)		NA	NA					46 x 23	80	500	Use where design shear stress is ≥5.0 psf

(1) Type refers to FDOT class and application.

TABLE I

Test	Unit	Test Method
Permittivity	sec⁻¹	ASTM-D-
AOS	US Sieve No.	ASTM-
Elongation	%	ASTM
Grab Tensile Strength	lb	A
Wide Width Tensile Strength	lb/in	
Maximum Design Velocity	fps	
Seam Strength	lb/in	
Puncture	lb	
Trapezoidal Tear	lb	
Ultraviolet Resistance	% Reti In Si	
Filtration Efficiency		
Flow Rate		

NOTES

1. Wide width tensile strength is expressed in units of measure of lb/in, in machine direction and cross direction, as MD x CD.
2. Manufacturer shall provide results in English Units.
3. Durability: The value represents the percent minimum textile strength (ASTM-D-4632) after weathering per ASTM-D-4355 for the test period.
4. Unless specifically restricted in COMMENTS column, any type meeting specification 985 may be used.

LAST REVISION 07/01/13	REVISION	DESCRIPTION	FDOT 2014 DESIGN STANDARDS	GEOTEXTILE	INDEX NO. 199	SHEET NO. 1 of 1

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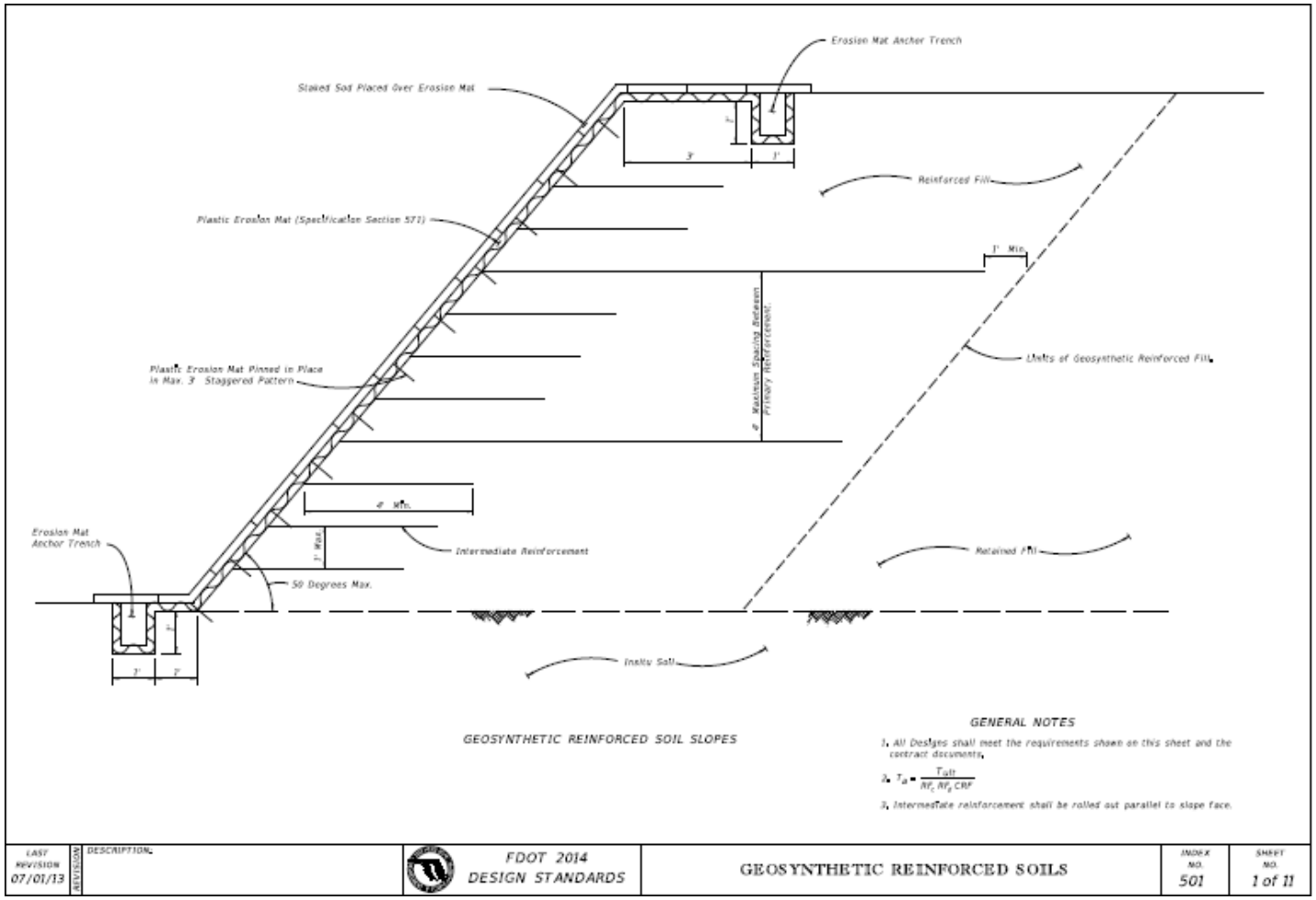
Geosynthetics Design Indices

- Index 501



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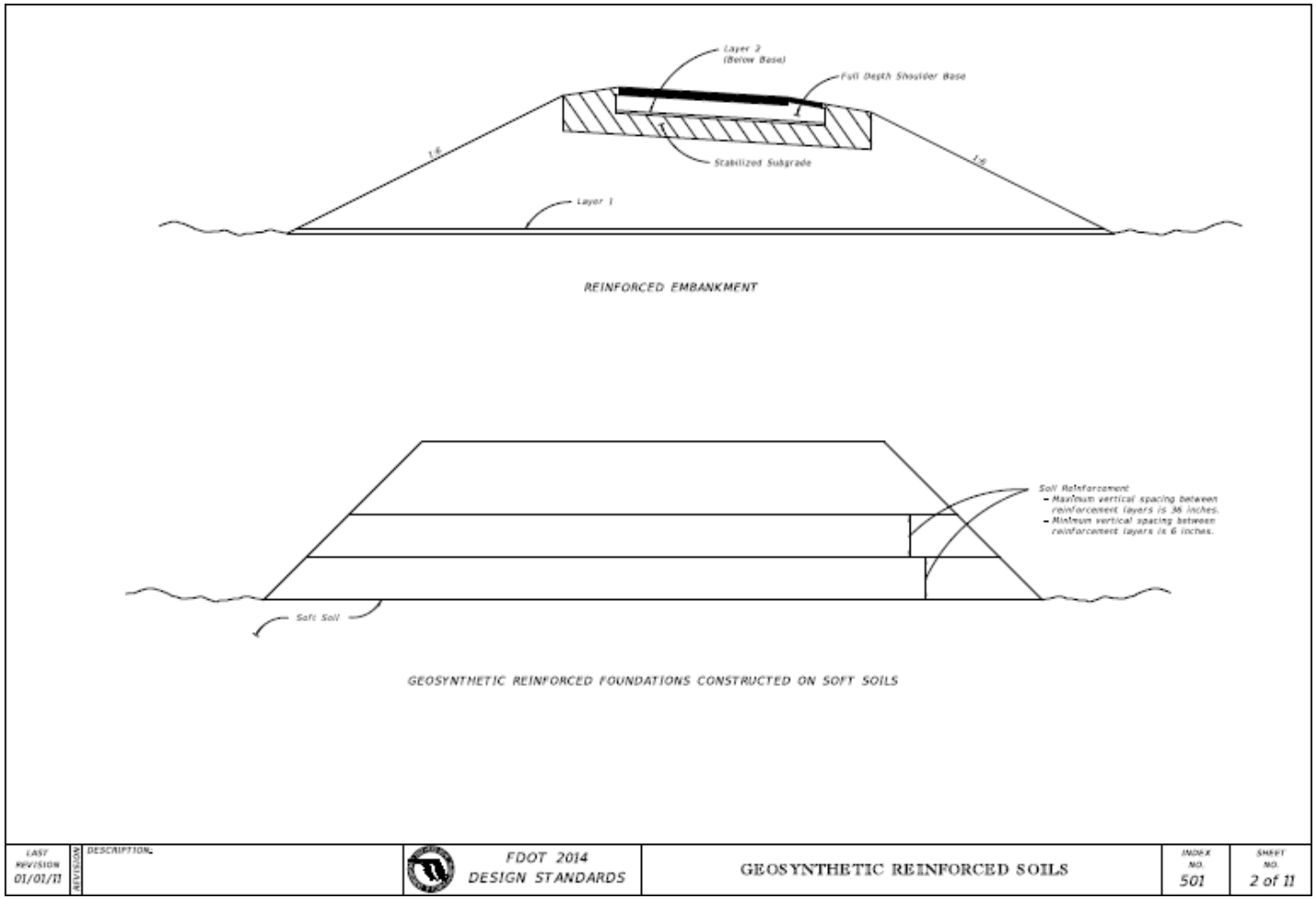
- Index 501



Geosynthetics Design Indices

- Index 501

Delete Sheets 3-11

Move Information to Spec 985

TABLE OF WOVEN GEOTEXTILE VALUES

PROPERTY		REQUIRED TEST METHOD			CONTRAC 70.70	GEOTEX 305ST	GEOTEX 2x2HF			GEOTEX 4x4HF	GEOTEX 4X6	TenCate RS380I	TenCate RS580I
Permittivity (0.05 sec⁻¹ Min.)		ASTM D 4491			0.20	0.04	0.65			0.40	0.26	0.90	1.0
UV Stability (Min. Retained Strength @ 500 hr.)		ASTM D 4355			70%	70%	70%			70%	70%	80%	80%
Burst Strength (psi)		ASTM D 6241			—	1,000	1,100		00	1,200	1,500	1,770	1,950
Grab Strength (Lb.)		ASTM D 4632	—		—	315			00/550	475/440	600/700	475/350	500/480
A_{90} S. (in.)		ASTM D 4751	0.02		1	0.0167			0.0236	0.033	0.312	0.0169	0.0169
Tensile Strength (Lb./Ft.)		ASTM D 4595											
Machine Direction	Ultimate (T_{ult})		13,800			2,100			4,800	4,850	4,800	4,500	4,800
	2% Strain		—			156			456	960	700	544	480
	5% Strain		4,800			564		92	1,452	2,400	1,200	1,800	1,440
Cross Direction	Ultimate		3,600	1		2,10		3,600	4,800	4,850	6,600	3,600	4,800
	2% Strain		—	—				400	1,380	1,320	1,000	1,020	1,740
	5% Strain		—	—				1,740	2,604	2,400	2,640	2,256	4,380
Strain @ Ultimate Tensile Strength		ASTM D 4595	12%	6%				10%	10%	8%	8%	8%	10%
Secant Modulus @ (lb/ft²)	2% Strain		—	—			00	27,000	22,800	48,000	48,000	30,000	24,000
	5% Strain		96,000	—	2		880	27,000	29,040	48,000	48,000	36,000	28,800
	10% Strain		120,000	—	2		480	24,000	31,200	48,000	48,000	36,000	36,000
Seam Breaking Strength (Lb./Ft.)		ASTM D 4884	2,400	—			—	—	—	—	—	2,700	3,000
Puncture Resistance (Lb.)		ASTM D 4833	—	—				180	170	190	280	—	—
Tear Strength (lb.)	Machine Direction	ASTM D 4833	—	—				180	250	180	180	120	180
	Cross Direction	ASTM D 4833	—	—				110	250	180	250	130	150
Soil-Geosynthetic Friction		ASTM D 6706	0.8	0		0		0.65	0.65	0.65	0.65	0.86	0.86
Creep Resistance-T_{creep} (Lb./Ft.)		ASTM D 5262	8,280	42		60		—	—	—	—	—	—
Creep Reduction Factor (T_{ult}/T_{creep})			1.67			3.5			5.0	5.0	5.0	—	—
Installation Damage (RF_D)	Sand	GRI : GG4 & GT7	1.10			1.4			1.4	1.4	1.4	—	—
	Limestone		1.2		.5	1.4			1.4	1.4	1.4	—	—
Durability (RF_d)	Chemical	ASTM D 5322			1.1	1.1	1.		1	1.1	1.1	—	—
	Biological	ASTM D1987 & G21			1.0	1.1	1.1			1.1	1.1	—	—
Joint Strength (RF_J)	Mechanical	ASTM D 4595, GRI : GG4 & GT7			—	—	—			—	—	—	—
	Overlap *	ASTM D 6706		0	1.0	1.2	1.2			1.0	1.2	—	—
Approved Application Usage				1.4	3	2	2			2	2	2.5	2.5

Approved Application Usage:
1 = Steepened Slopes
2 = Reinforcement of Foun
3 = Both Steepened Slop
Foundations over Sa
4 = Reinforced Embar
5 = Construction Ex

* Minimum 3' Overlap

APPROVED GEOSYNTHETIC PRODUCTS
(WOVEN GEOTEXTILE)
APPLICATION AND PROPERTIES

LAST REVISION	REVISION	DESCRIPTION				INDEX NO.	SHEET NO.
07/01/13			FDOT 2014 DESIGN STANDARDS	GEOSYNTHETIC RE		501	3 of 11

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Specification 985 & APL

- Materials Specification
- Requires Contractor to choose Geotextiles & Geogrids from APL.
  - ✓ Application Type (D-2, E-4, etc.)
  - ✓ Soil Type (Drainage Applications)
  - ✓ Requirements on the Plans (min. strength, etc.)

Specification 985 & APL

- Provides testing requirements for APL listing
  - ✓ Subdivides Drainage Geotextiles based on soil type.
- Effective with 2015 Spec Book
  - ✓ Same Implementation as 2015 Standard Indices
- Industry Review starts next week

Specification 985 & APL

9850000
All Jobs

GEOTEXTILE FABRICS.
(REV 6-3-14)

SECTION 985 is deleted and the following substituted:

SECTION 985
GEOSYNTHETIC MATERIALS

985-1 General: Geosynthetic materials shall be geotextiles (woven or non-woven) or geogrids (woven or extruded) that are used for drainage, erosion control, reinforcement, separation or stabilization.

985-2 Product Acceptance: Use only 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 identify the application type in accordance with this specification, provide documentation that the product meets all the requirements of this specification and include independently certified test reports that the material meets the physical requirements of the application type.

Products will be listed on the APL according to geosynthetic application type. Structural geosynthetics are listed with property values.

985-3 Applications: Geosynthetics are used for nonstructural and structural applications as follows:

985-3.1 Drainage: Geotextile materials used for drainage are considered nonstructural and are subdivided as follows:

Drainage Geotextile Type	Application Description	Standard Index Number
D-1	Revetment (Special)	
D-2	Revetment (Standard)	
	Articulating Block	
	Gabions	281
	Rock, Rubble, and Broken Concrete	
	Ditch Pavement (Rubble Riprap)	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
D-4/6	Slope Pavement	
	Ditch Pavement (Sand-Cement Riprap or Concrete)	281

Specification 985 & APL

D-5	Mechanically Stabilized Retaining Wall (Joint Cover)	
	Cast-In-Place Retaining Wall	

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 the methods and meet the requirements listed in Table 1.

985-3.2 Erosion Control: Geotextile materials are used for silt fence, staked silt barrier and plastic erosion mats. Materials used for erosion control are considered nonstructural and are subdivided as follows:

Erosion Type	Application 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)

Materials for erosion control applications must be tested in accordance with the methods and meet the requirements listed in Table 2.

985-3.3 Reinforcement, Separation and Stabilization: Structural geosynthetics used for reinforcement, separation and stabilization are sub divided for use in one or more of the following applications:

Application Type	Application 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

Materials for reinforcement, separation and stabilization applications must be tested in accordance with the methods listed in Table 3.

985-4 Material Requirements.

985-4.1 General:

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 that 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 material shall be free of any treatment which may significantly alter its physical properties. The edges of the geotextile shall be selvaged or otherwise finished to prevent the outer yarn from pulling away from the material.

Specification 985 & APL

For Structural Geosynthetics, use primary and secondary reinforcing elements consisting of a regular array of tensile elements that have sufficient reinforcement strength to perform the prime functions of reinforcement.

985-4.2 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 types	Class for Type D1, D2 & D3 Materials listed below
-200* =< 15%	a
-200* 15% to 50%	b
-200* >-50%	c
-200* >-50% with Plastic Index >-7	d
*Percentage passing the number 200 US Standard Sieve according to AASHTO T 88	

Specification 985 & APL

Table 1 Test Methods and Requirements for Drainage Geotextiles			
Property	D-1	D-2	D-3
Minimum Permittivity (Sec - 1) per ASTM D 4491	D-1a = 0.7 D-1b = 0.2 D-1c = 0.1 D-1d = 0.1	D-2a = 0.7 D-2b = 0.2 D-2c = 0.1 D-2d = 0.1	D-3a = 0.5 D-3b = 0.2 D-3c = 0.1 D-3d = 0.1
Maximum AOS (US Sieve No.) per ASTM D 4751	D-1a = 40 D-1b = 60 D-1c = 70 D-1d = 50	D-2a = 40 D-2b = 60 D-2c = 70 D-2d = 50	D-3a = 40 D-3b = 60 D-3c = 70 D-3d = 50
Minimum Grab Tensile Strength (lb) per ASTM D 4632	315	Woven Mono-filament = 248 Other Woven Geotextiles: Elongation -<50% = 315 Elongation >-50% = 203	Elongation -<50% = 248 Elongation >-50% = 158
Minimum Sewn Strength (lb) per ASTM D 4632	283	Woven Mono-filament = 223 Other Woven Geotextiles: Elongation -<50% = 283 Elongation >-50% = 182	Elongation -<50% = 223 Elongation >-50% = 142
Minimum Puncture Strength (lb) per ASTM D 6241	618	Woven Mono-filament = 495 Other Woven Geotextiles: Elongation -<50% = 618 Elongation >-50% = 433	Elongation -<50% = 495 Elongation >-50% = 309
Minimum Trapezoidal Tear (lb) per ASTM D 4533	113	Woven Mono-filament = 57 Other Woven Geotextiles: Elongation -<50% = 113 Elongation >-50% = 79	Woven Mono-filament = 57 Other Geotextiles: Elongation -<50% = 90 Elongation >-50% = 57
Minimum UV Resistance per ASTM D 4355 (% Retained Strength)	50% @ 500 Hours	50% @ 500 Hours	50% @ 500 Hours
Limitations	Woven Monofilament Geotextiles only (Elongation -<50%).	Woven Geotextiles only. No Slit Film Geotextiles allowed.	No Slit Film Geotextiles allowed.

Specification 985 & APL

Table 1 (continued)		
Property	D-4/6	D-5
Minimum Permittivity (Sec^{-1}) per ASTM D 4491	0.5	0.5
Maximum AOS (US Sieve No.) per ASTM D 4751	40	40
Minimum Grab Tensile Strength (lb) per ASTM D 4632	180	180
Minimum Seam Strength (lb) per ASTM D 4632	162	162
Minimum Puncture Strength (lb) per ASTM D 6241	223	223
Minimum Trapezoidal Tear (lb) per ASTM D 4533	35	40
Minimum UV Resistance per ASTM D 4355 (% Retained Strength)	50% @ 500 Hours	50%@ 500 Hours

Specification 985 & APL

Table 2					
Test Methods and Requirements for Erosion Control Materials					
Property	E-1	E-2	E-3	E-4	E-5
Permittivity (Sec $^{-1}$) per ASTM D 4491	0.05	0.05			
Grab Tensile Strength (lb) per ASTM D 4632	90	90			
Minimum UV Resistance per ASTM D 4355 (% Retained Strength)	80% @ 500 Hours	80% @ 150 Hours	80% @ 500 Hours	80% @ 500 Hours	80% @ 500 Hours
Wide Width Tensile Strength **(lb/in) per ASTM D 4595			11.4 x 5.7	22.8 x 11.4	45.7 x 22.8
Filtration Efficiency (%) per ASTM D 5141	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 lb/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.

Specification 985 & APL

Table 3			
Test Methods and Requirements for Structural Geosynthetics			
Property	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 D 4491	
UV Stability (Min Retained Strength @ 500 hr)	R – 5	ASTM D 4355	ASTM D 4355
Puncture Strength (lb)	R – 5	ASTM D 6241	
Grab Strength (lb)	R – 5	ASTM D 4632	
Opening Size	R – 1, 2, 3, 4, 5	AOS (US Sieve No.) ASTM D 4751	Aperture Size (in x in)
Tensile Strength (lb/ft)		ASTM D 4595	ASTM D 6637
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 (lb)		ASTM D 4533	
Machine Direction	R – 5		
Cross Direction	R – 5		
Soil-Geosynthetic Friction	R – 1, 2, 3	ASTM D 6706	ASTM D 6706
Creep Resistance-T_{creep} (lb/ft)	R – 2, 3, 4	ASTM D 5262	ASTM 5262
Creep Reduction Factor (T_{ult}/T_{creep})	R – 2, 3, 4		
Installation Damage (RF_{id})		GRI: GT7	GRI: GG4(a) & GG4(b)
Sand	R – 2, 3, 4		
Limestone	R – 2, 3, 4		
Durability (RF_d)		GRI: GT7	GRI: GG4(a) & GG4(b)
Chemical	R – 2, 3, 4		
Biological	R – 2, 3, 4		
Joint Strength (RF_j)			
Mechanical	R – 2, 3	GRI: GT7	GRI: GG4(a) & GG4(b)
Seam	R – 2, 3	ASTM D 4884	

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Specification 985 & APL

985-4.3 Overlaps and Seams: Overlaps shall be 3 ft unless specified otherwise in the Contract Documents for each particular application. To reduce overlaps, the geosynthetic material may be sewn together per manufacture recommendations. Seams of the material shall be sewn with thread meeting the chemical requirements and minimum seam strength requirements.

985-4.4 Packaging and Labeling: Geosynthetics shall be packaged in a protective covering sufficient to protect the material from sunlight, dirt, and other debris during shipment and storage. The manufacturer's name, product name, style number, roll dimensions and L/OT numbers must be clearly labeled on all packaging. During shipping and storage, protect the geosynthetic from physical damage, debris and from temperatures greater than 140°F.

985-5 Certification.

In accordance with Section 6, provide manufacturer's certification that the material meets the requirements of this specification. The manufacturer's certification shall be attested to by a person having legal authority to bind the manufacturing company. Provide the State Materials Office with two (8 in. by 10 in.) samples of the geosynthetic material for product identification. The manufacturer shall maintain test records as required by this Specification. These records shall be made available to the Department upon request.

Benefit to Manufacturers

- Shorter product acceptance to usage period
  - ✓ APL Products – Approval prior to Time of Use
  - ✓ Standard Index – Approval prior to edit deadline for the current Design Standards Index

Benefit to Construction

- APL listed by Specification; under 985:
  - ✓ Material Application Type
    - Application Type D-3a
      - Approved Choice 1
      - Approved Choice 2
    - Application Type E-1
      - Approved Choice 1
      - Approved Choice 2
    - Application Type R-3
      - Approved Choice 1
        - Submitted Test Results for Choice 1
      - Approved Choice 2
        - Submitted Test Results for Choice 2

Impacts on Design

- For projects letting in January 2015 and later, the following revisions in Plans & Spec Packages are needed:
  - ✓ Remove references to Standard Index 199
  - ✓ Revise requirements for materials selection from Standard Index 501
    - e.g. “Geogrid/Geotextile approved for Application x in Standard Index 501” to “R-x Geosynthetic”
  - ✓ Just show the Application Type (with any special requirements) in the call-out on the Plans, TSP, etc.
- Design Standards Index references to “Index 199” will now reference “Specifications Section 985”

Questions?

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