

**985 GEOSYNTHETIC MATERIALS.**  
**(REV 9-2-14) (FA 9-10-14) (1-15)**

SECTION 985 is deleted and the following substituted:

**SECTION 985**  
**~~GEOTEXTILE FABRICS~~GEOSYNTHETIC MATERIALS**

**985-1 ~~Fabric~~GeneralDescription.**

**985-1.1 General:** ~~Geotextiles shall be woven or nonwoven fabrics that will allow the passage of water. Geotextiles shall be packaged in a protective covering sufficient to protect it from sunlight, dirt, and other debris during shipment and storage, upon which the manufacturer's name, product name, style number, roll dimensions and LOT numbers are clearly labeled.~~**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.*

~~985-1.2 Application:~~ The applications of geotextile fabrics are divided into the following three main classes:

~~1. Drainage under all rubble riprap, including cyclopean stone and under gabions; wrapped around drains, pipe joints, and edge drains; filter behind walls, etc.~~

~~2. 985-1.2 Material Selection: Select geosynthetic materials that meet the required permeability and AOS based on test results on the soil or fill adjacent to the geotextile for gradation.~~

**985-2 ~~Physical Requirements~~Materials.**

**985-2.1 General Requirements:** Unless restricted in the Plans or Specifications, the ~~geotextile~~*synthetic fabric material* shall be a woven ~~or~~, non woven *or extruded fabric 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 ~~(except for subsurface and stabilization classification)~~, heat exposure and potential chemically damaging environment. ~~The fabric shall be free of any treatment which may significantly alter its physical properties.~~ The edges of the *fabric material* shall be selvaged or otherwise finished to prevent the outer yarn from pulling away from the *fabric material and shall be free of any treatment which may significantly alter its physical properties.* ~~The fabric shall conform to the physical requirements on Design Standards, Index No. 199 according to its application.~~

~~For structural geosynthetics, use primary and secondary reinforcing elements consisting of a regular array of tensile elements with sufficient reinforcement strength to perform the prime functions of reinforcement.~~

**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.*

<i>Geotextile Selection</i>	
<i>In-situ Soil Types % passing a No. 200 Sieve*</i>	<i>Class for Type D1, D2, D3 Materials (see Table 1.1)</i>
<i>&lt; 15%</i>	<i>a</i>
<i>15% to 50%</i>	<i>b</i>
<i>&gt; 50%</i>	<i>c</i>
<i>&gt; 50% with Plastic Index &gt;7</i>	<i>d</i>
<i>*as per AASHTO T88.</i>	

<p align="center"><i>Table 1.1</i>  <i>Drainage Geotextiles</i>  <i>Test Methods and Requirements for Types D-1, D-2 and D-3</i></p>			
<i>Property/Test Method</i>	<i>D-1</i>	<i>D-2</i>	<i>D-3</i>
<i>Minimum Permittivity (Sec - 1) per ASTM D4491</i>	<i>D-1a = 0.7 D-1b = 0.2 D-1c = 0.1 D-1d = 0.1</i>	<i>D-2a = 0.7 D-2b = 0.2 D-2c = 0.1 D-2d = 0.1</i>	<i>D-3a = 0.5 D-3b = 0.2 D-3c = 0.1 D-3d = 0.1</i>
<i>Maximum AOS (US Sieve No.) per ASTM D4751</i>	<i>D-1a = 40 D-1b = 60 D-1c = 70 D-1d = 50</i>	<i>D-2a = 40 D-2b = 60 D-2c = 70 D-2d = 50</i>	<i>D-3a = 40 D-3b = 60 D-3c = 70 D-3d = 50</i>
<i>Minimum Grab Tensile Strength (lbs) per ASTM D4632</i>	<i>315</i>	<i>Woven Monofilament = 248 Other Woven Geotextiles: Elongation &lt;50% = 315 Elongation &gt;50% = 203</i>	<i>Elongation &lt;50% = 248 Elongation &gt;50% = 158</i>
<i>Minimum Sewn Strength (lbs) per ASTM D4632</i>	<i>283</i>	<i>Woven Monofilament = 223 Other Woven Geotextiles: Elongation &lt;50% = 283 Elongation &gt;50% = 182</i>	<i>Elongation &lt;50% = 223 Elongation &gt;50% = 142</i>
<i>Minimum Puncture Strength (lbs) per ASTM D6241</i>	<i>618</i>	<i>Woven Monofilament = 495 Other Woven Geotextiles: Elongation &lt;50% = 618 Elongation &gt;50% = 433</i>	<i>Elongation &lt;50% = 495 Elongation &gt;50% = 309</i>
<i>Minimum Trapezoidal Tear (lbs) per ASTM D4533</i>	<i>113</i>	<i>Woven Monofilament = 57 Other Woven Geotextiles: Elongation &lt;50% = 113 Elongation &gt;50% = 79</i>	<i>Woven Monofilament = 57 Other Geotextiles: Elongation &lt;50% = 90 Elongation &gt;50% = 57</i>
<i>Minimum UV Resistance per ASTM D4355 (% Retained Strength)</i>	<i>50% @ 500 hours</i>	<i>50% @ 500 hours</i>	<i>50% @ 500 hours</i>
<i>Limitations</i>	<i>Woven Monofilament Geotextiles only</i>	<i>Woven Geotextiles only. No Slit Film Geotextiles allowed.</i>	<i>No Slit Film Geotextiles allowed.</i>

<p align="center"><i>Table 1.2</i>  <i>Test Methods and Requirements for Drainage Geotextiles</i>  <i>Types D-4/6 and D-5</i></p>		
<i>Property/Test Method</i>	<i>D-4/6</i>	<i>D-5</i>
<i>Minimum Permittivity (Sec<sup>-1</sup>) per ASTM D4491</i>	<i>0.5</i>	<i>0.5</i>
<i>Maximum AOS (US Sieve No.) per ASTM D4751</i>	<i>40</i>	<i>40</i>
<i>Minimum Grab Tensile Strength (lbs) per ASTM D4632</i>	<i>180</i>	<i>180</i>
<i>Minimum Sewn Strength (lbs) per ASTM D4632</i>	<i>162</i>	<i>162</i>
<i>Minimum Puncture Strength (lbs) per ASTM D6241</i>	<i>223</i>	<i>223</i>
<i>Minimum Trapezoidal Tear (lbs) per ASTM D4533</i>	<i>35</i>	<i>40</i>
<i>Minimum UV Resistance per ASTM D4355</i> <i>(% Retained Strength)</i>	<i>50% @ 500 hours</i>	<i>50% @ 500 hours</i>

<p align="center"><i>Table 2</i>  <i>Test Methods and Requirements for Erosion Control Materials</i></p>					
<i>Property/Test Method</i>	<i>E-1</i>	<i>E-2</i>	<i>E-3</i>	<i>E-4</i>	<i>E-5</i>
<i>Permittivity (Sec<sup>-1</sup>)</i> <i>per ASTM D4491</i>	<i>0.05</i>	<i>0.05</i>			
<i>Grab Tensile Strength</i> <i>(lbs) per ASTM D4632</i>	<i>90</i>	<i>90</i>			
<i>Minimum UV Resistance</i> <i>per ASTM D4355</i> <i>(% Retained Strength)</i>	<i>80%</i> <i>@ 500 hours</i>	<i>80%</i> <i>@ 150 hours</i>	<i>80% @ 500 hours</i>		
<i>Wide Width Tensile</i> <i>Strength ** (lbs/in)</i> <i>per ASTM D4595/6818</i>			<i>11.4 x 5.7</i>	<i>22.8 x 11.4</i>	<i>45.7 x 22.8</i>
<i>Filtration Efficiency (%)</i> <i>per ASTM D5141</i>	<i>75% and min.</i> <i>flow rate of</i> <i>0.3 gal/sf/min</i>				
<i>Design Shear***</i>			<i>≥2.1 psf</i>	<i>≥3.6 psf</i>	<i>≥5.0 psf</i>
<p><i>** Wide Width Tensile Strength is expressed in units of measure of lbs/in, in machine direction and cross direction as MD x CD.</i>  <i>*** 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.</i></p>					

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 ( $\text{sec}^{-1}$ )	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- $T_{\text{creep}}$ (lbs/ft)	R - 2, 3, 4	ASTM D5262	ASTM D5262
Creep Reduction Factor ( $T_{\text{ult}}/T_{\text{creep}}$ )	R - 2, 3, 4		
Installation Damage ( $RF_c$ )		GRI: GT7	GRI: GG4(a) & GG4(b)
Sand	R - 2, 3, 4		
Limestone	R - 2, 3, 4		
Durability ( $RF_d$ )			
Chemical	R - 2, 3, 4	GRI: GT7	GRI: GG4(a) & GG4(b)
Biological	R - 2, 3, 4	GRI: GT7	GRI: GG4(a) & GG4(b)

<p align="center"><i>Table 3</i></p> <p align="center"><i>Test Methods and Requirements for Structural Geosynthetics</i></p>			
<i>Property/Test Method</i>	<i>Structural Application Type</i>	<i>Test Methods for Woven Geotextiles</i>	<i>Test Methods for Woven or Extruded Geogrids</i>
<i>Joint Strength (RF<sub>j</sub>)</i>			
<i>Mechanical</i>	<i>R - 2, 3</i>	<i>GRI: GT7</i>	<i>GRI: GG4(a) &amp; GG4(b)</i>
<i>Sewn</i>	<i>R - 2, 3</i>	<i>ASTM D4884</i>	

**985-42.3 Overlaps and Seams:** Overlaps shall be ~~as 3-ft three feet unless in accordance with the manufacturer's recommendations unless specified otherwise in the Plans, Specifications, or Design Standards~~ *Contract Documents* for ~~each~~ *a* particular application. To reduce overlaps, the ~~geotextile fabric~~ *geosynthetic material* may be sewn together ~~per in accordance with the manufacturer's recommendations. Sew the S seams of the fabric material shall be sewn~~ with thread meeting the chemical requirements and minimum seam strength requirements ~~in Tables 1.1, 1.2 and 3 given for the fabric and application as shown on Design Standards, Index No. 199.~~

**985-42.4 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. ~~During shipping and storage, protect the geosynthetic from physical damage, debris and from temperatures greater than 140°F.~~

### **985-53 Product Acceptance and Certification.**

**985-3.1 Product Acceptance:** ~~Use only~~ 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. Structural geosynthetics are listed with property values.

**985-3.2 Certification:** The Contractor shall ~~P~~provide the Engineer a ~~manufacturer's certification from the manufacturer, confirming to the requirements of Section 6, that the material meets the requirements of this Section and is appropriate for the intended use. The manufacturer's certification shall be attested to by a person having legal authority to bind the manufacturing company. Also, The manufacturer shall also provide the Engineer with two 8 inch by 10 inch samples of the geosynthetic material for product identification. The manufacturer shall maintain test records as required by this Specification and these records shall be made available to the Department upon request. 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.

~~—Furnish two certified copies of a test report from the manufacturer certifying that the geotextile to be incorporated into the completed project in accordance with Section 6, provide manufacturer's certification that the material meets the requirements of this Specification and~~

~~the Design Standards, Index No. 199. The certified test reports specification. The manufacturer's certification shall be attested to by a person having legal authority to bind the manufacturing company. Also, furnish Provide the State Materials Office with two (4 inch 8 in. by 8 inch) 10 in.) samples of the geotextile 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.~~

~~985-2 Product Acceptance: Use only products listed on the Department's Approved Qualified Products List (QAPL). 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 QAPL according to geosynthetic application type. Structural geosynthetics are listed with property values.~~

### **985-34 Applications:-**

**985-4.1 Nonstructural:** ~~Geosynthetics are used for nonstructural and structural applications as follows:~~

**985-34.1.1 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. Geotextile materials used for drainage are considered nonstructural and are subdivided as follows:~~

<i>Drainage Applications</i>		
<i>Drainage Geotextile Type</i>	<i>Application Description</i>	<i>Design Standards Index Number.</i>
<i>D-1</i>	<i>Revetment (Special)</i>	
<i>D-2</i>	<i>Revetment (Standard)</i>	
	<i>Articulating Block</i>	
	<i>Gabions</i>	<i>281</i>
	<i>Rock, Rubble, and Broken Concrete</i>	
	<i>Ditch Pavement (Rubble Riprap)</i>	<i>281</i>
	<i>Joint Cover for Mechanically Stabilized Retaining Wall Supporting Spread Footing Foundations</i>	
<i>D-3</i>	<i>Underdrain</i>	<i>286</i>
	<i>French Drain</i>	<i>285</i>
	<i>Sheet Piling Filter</i>	
	<i>Filter Fabric Jacket (Culvert)</i>	<i>280</i>
	<i>Concrete Pavement Subdrainage</i>	<i>287</i>
<i>D-4/6</i>	<i>Slope Pavement</i>	
	<i>Ditch Pavement (Sand-Cement Riprap or Concrete)</i>	<i>281</i>
<i>D-5</i>	<i>Mechanically Stabilized Retaining Wall (Joint Cover)</i>	<i>548</i>
	<i>Cast-In-Place Retaining Wall</i>	



~~Select geotextile/synthetic 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.~~

**985-34.1.2 Erosion Control:** ~~Geotextile materials are used for silt fence, staked silt barrier, plastic erosion mat, and plastic erosion mats. Materials used for erosion control are considered nonstructural and are subdivided as follows:~~ *Materials used for erosion control applications must be tested in accordance with and meet the physical requirements in 985-2.2, Table 2.*

~~3. Stabilization separator between embankment and soft subsoil, reinforcement and pipe bedding.~~  
985-2 Physical

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

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

**985-34.32 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.* ~~Structural geosynthetics used for reinforcement, separation and stabilization are sub-divided for use in one or more of the following applications:~~

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

~~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 geotextile fabric ~~geosynthetic material~~ shall be a woven, ~~non-woven~~ or non-woven fabric ~~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 (except for subsurface and stabilization classification), heat exposure and potential chemically damaging environment. The fabric ~~material~~ shall be free of any treatment which may significantly alter its physical properties. The edges of the fabric ~~geotextile~~ shall be selvaged or otherwise finished to prevent the outer yarn from pulling away from the fabric. The fabric shall conform to the physical requirements on Design Standards, Index No. 199 according to its application. ~~material.~~

~~985— 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.~~

<i>Geotextile Selection</i>	
<i>In-situ Soil types</i>	<i>Class for Type D1, D2 &amp; D3, and E-3, E-4 &amp; E-5 Materials listed below</i>
<del>200* &lt; 15%</del>	<i>a</i>
<del>200* 15% to 50%</del>	<i>b</i>
<del>200* &gt; 50%</del>	<i>c</i>
<del>200* &gt; 50% with Plastic Index &gt; 7</del>	<i>d</i>
*Percentage passing the number 200 US Standard Sieve according to AASHTO T 88	

<b>Table 1</b>			
<i>Test Methods and Requirements for Drainage Geotextiles</i>			
<i>Property</i>	<i>D-1</i>	<i>D-2</i>	<i>D-3</i>
<i>Minimum Permittivity (Sec-1) per ASTM D 4491</i>	<i>D-1a = 0.7 D-1b = 0.2 D-1c = 0.1 D-1d = 0.1</i>	<i>D-2a = 0.7 D-2b = 0.2 D-2c = 0.1 D-2d = 0.1</i>	<i>D-3a = 0.5 D-3b = 0.2 D-3c = 0.1 D-3d = 0.1</i>
<i>Maximum AOS (US Sieve No.) per ASTM D 4751</i>	<i>D-1a = 40 D-1b = 60 D-1c = 70 D-1d = 50</i>	<i>D-2a = 40 D-2b = 60 D-2c = 70 D-2d = 50</i>	<i>D-3a = 40 D-3b = 60 D-3c = 70 D-3d = 50</i>
<i>Minimum Grab Tensile Strength (lb) per</i>	<i>315</i>	<i>Woven Mono-filament = 248 Other Woven Geotextiles:</i>	<i>Elongation &lt; 50% = 248 Elongation &gt; 50% = 158</i>

<del>ASTM D 4632</del>		<del>Elongation &lt;50% = 315 Elongation &gt;50% = 203</del>	
<del>Minimum Sewn Strength (lb) per ASTM D 4632</del>	<del>283</del>	<del>Woven Mono-filament = 223 Other Woven Geotextiles: Elongation &lt;50% = 283 Elongation &gt;50% = 182</del>	<del>Elongation &lt;50% = 223 Elongation &gt;50% = 142</del>
<del>Minimum Puncture Strength (lb) per ASTM D 6241</del>	<del>618</del>	<del>Woven Mono-filament = 495 Other Woven Geotextiles: Elongation &lt;50% = 618 Elongation &gt;50% = 433</del>	<del>Elongation &lt;50% = 495 Elongation &gt;50% = 309</del>
<del>Minimum Trapezoidal Tear (lb) per ASTM D 4533</del>	<del>113</del>	<del>Woven Mono-filament = 57 Other Woven Geotextiles: Elongation &lt;50% = 113 Elongation &gt;50% = 79</del>	<del>Woven Mono-filament = 57 Other Geotextiles: Elongation &lt;50% = 90 Elongation &gt;50% = 57</del>
<del>Minimum UV Resistance per ASTM D 4355 (% Retained Strength)</del>	<del>50% @ 500 Hours</del>	<del>50% @ 500 Hours</del>	<del>50% @ 500 Hours</del>
<del>Limitations</del>	<del>Woven Monofilament Geotextiles only (Elongation &lt;50%).</del>	<del>Woven Geotextiles only. No Slit Film Geotextiles allowed.</del>	<del>No Slit Film Geotextiles allowed.</del>

<b>Table 1 (continued)</b>		
<b>Property</b>	<b>D-4/6</b>	<b>D-5</b>
<del>Minimum Permittivity (Sec<sup>-1</sup>) per ASTM D 4491</del>	<del>0.5</del>	<del>0.5</del>
<del>Maximum AOS (US Sieve No.) per ASTM D 4751</del>	<del>40</del>	<del>40</del>
<del>Minimum Grab Tensile Strength (lb) per ASTM D 4632</del>	<del>180</del>	<del>180</del>
<del>Minimum Sewn Strength (lb) per ASTM D 4632</del>	<del>162</del>	<del>162</del>
<del>Minimum Puncture Strength (lb) per ASTM D 6241</del>	<del>223</del>	<del>223</del>

<i>Minimum Trapezoidal Tear (lb) per ASTM D 4533</i>	<i>35</i>	<i>40</i>
<i>Minimum UV Resistance per ASTM D 4355 (% Retained Strength)</i>	<i>50% @ 500 Hours</i>	<i>50% @ 500 Hours</i>

<b>Table 2</b>					
<i>Test Methods and Requirements for Erosion Control Materials</i>					
<i>Property</i>	<i>E-1</i>	<i>E-2</i>	<i>E-3</i>	<i>E-4</i>	<i>E-5</i>
<i>Permittivity (Sec<sup>-1</sup>) per ASTM D 4491</i>	<i>0.05</i>	<i>0.05</i>			
<i>Grab Tensile Strength (lb) per ASTM D 4632</i>	<i>90</i>	<i>90</i>			
<i>Minimum UV Resistance per ASTM D 4355 (% Retained Strength)</i>	<i>80% @ 500 Hours</i>	<i>80% @ 150 Hours</i>	<i>80% @ 500 Hours</i>	<i>80% @ 500 Hours</i>	<i>80% @ 500 Hours</i>
<i>Wide Width Tensile Strength <sup>**</sup>(lb/in) per ASTM D 4595</i>			<i>11.4 x 5.7</i>	<i>22.8 x 11.4</i>	<i>45.7 x 22.8</i>
<i>Filtration Efficiency (%) per ASTM D 5141</i>	<i>75% and min. flow rate of 0.3 gal/sf/min</i>				
<i>Design Shear***</i>			<i>≥2.1 psf</i>	<i>≥3.6 psf</i>	<i>≥5.0 psf</i>
<sup>**</sup> Wide Width Tensile Strength is expressed in units of measure of lb/in, in machine direction and cross direction as MD x CD. <sup>***</sup> 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.					

<b>Table 3</b>			
<i>Test Methods and Requirements for Structural Geosynthetics</i>			
<i>Property</i>	<i>Structural Application Type</i>	<i>Test Methods for Woven Geotextiles</i>	<i>Test Methods for Woven or Extruded Geogrids</i>
<i>Permittivity (sec<sup>-1</sup>)</i>	<i>R—1, 2, 3, 4, 5</i>	<i>ASTM D 4491</i>	
<i>UV Stability (Min Retained Strength @ 500 hr)</i>	<i>R—3</i>	<i>ASTM D 4355</i>	<i>ASTM D 4355</i>
<i>Puncture Strength (lb)</i>	<i>R—5</i>	<i>ASTM D 6241</i>	
<i>Grab Strength (lb)</i>	<i>R—5</i>	<i>ASTM D 4632</i>	
<i>Opening Size</i>	<i>R—1, 2, 3, 4, 5</i>	<i>AOS (US Sieve No.)</i>	<i>Aperture Size (in x</i>

		<del>ASTM D-4751</del>	<del>in)</del>
<del>Tensile Strength (lb/ft)</del>		<del>ASTM D-4595</del>	<del>ASTM D-6637</del>
<del>Machine Direction Ultimate, (<math>T_{ult}</math>)</del>			
<del>2% Strain</del>	<del>R—1, 3</del>		
<del>5% Strain</del>	<del>R—2, 3, 4, 5</del>		
<del>10% Strain</del>	<del>R—1, 2, 3, 4, 5</del>		
<del>Cross Direction Ultimate</del>			
<del>2% Strain</del>	<del>R—1, 2, 3, 4, 5</del>		
<del>5% Strain</del>	<del>R—1, 2, 3, 4, 5</del>		
<del>10% Strain</del>	<del>R—1, 2, 3, 4, 5</del>		
<del>Strain @ Ultimate Tensile Strength</del>	<del>R—1, 2, 3, 4, 5</del>		
<del>Tear Strength (lb)</del>		<del>ASTM D-4533</del>	
<del>Machine Direction</del>	<del>R—5</del>		
<del>Cross Direction</del>	<del>R—5</del>		
<del>Soil-Geosynthetic Friction</del>	<del>R—1, 2, 3</del>	<del>ASTM D-6706</del>	<del>ASTM D-6706</del>
<del>Creep Resistance <math>T_{creep}</math> (lb/ft)</del>	<del>R—2, 3, 4</del>	<del>ASTM D-5262</del>	<del>ASTM 5262</del>
<del>Creep Reduction Factor (<math>T_{ult}/T_{creep}</math>)</del>	<del>R—2, 3, 4</del>		
<del>Installation Damage (<math>RF_e</math>)</del>		<del>GRI: GT7</del>	<del>GRI: GG4(a) &amp; GG4(b)</del>
<del>Sand</del>	<del>R—2, 3, 4</del>		
<del>Limestone</del>	<del>R—2, 3, 4</del>		
<del>Durability (<math>RF_d</math>)</del>			
<del>Chemical</del>	<del>R—2, 3, 4</del>	<del>ASTM D-5322GRI: GT7</del>	<del>ASTM D-5322GRI: GG4(a) &amp; GG4(b)</del>
<del>Biological</del>	<del>R—2, 3, 4</del>	<del>ASTM D-1987, G21, &amp; G22GRI: GT7</del>	<del>ASTM G21 &amp; G22GRI: GG4(a) &amp; GG4(b)</del>
<del>Joint Strength (<math>RF_j</math>)</del>			
<del>Mechanical</del>	<del>R—2, 3</del>	<del>GRI: GT7</del>	<del>GRI: GG4(a) &amp; GG4(b)</del>
<del>Sewn</del>	<del>R—2, 3</del>	<del>ASTM D-4884</del>	

~~985-4.3 Overlaps and Seams:~~ Overlaps shall be as ~~3 ft unless specified otherwise in the Plans, Specifications, or Design Standards~~ ~~Contract Documents~~ for each particular application. To reduce overlaps, the geotextile fabric ~~geosynthetic material~~ may be sewn together ~~per manufacture recommendations~~. Seams of the fabric ~~material~~ shall be sewn with thread meeting the chemical requirements and minimum seam strength requirements given for the fabric and application as shown on Design Standards, Index No. 199..

~~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 LOT 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.**

~~\_\_\_\_\_Furnish two certified copies of a test report from the manufacturer certifying that the geotextile to be incorporated into the completed project. In accordance with Section 6, provide manufacturer's certification that the material meets the requirements of this Specification and the Design Standards, Index No. 199. The certified test report specification. The manufacturer's certification shall be attested to by a person having legal authority to bind the manufacturing company. Also, furnish Provide the State Materials Office with two (4 inch 8 in. by 8 inch) 10 in.) samples of the geotextile 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.~~