

## GRI-GN4 – Standard Specification for Required Properties and Testing Frequency for Biplanar Geonets and Biplanar Geonet Composites

- spec is not for triplanar geonets, or for geospacers
- includes the geonet by itself, and also single or double sided geotextile composites



biplanar geonet



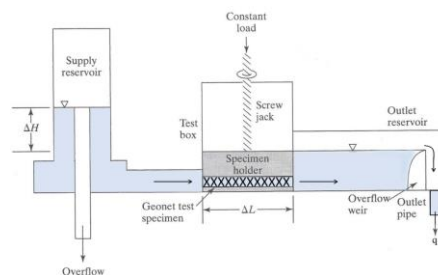
single-sided geocomposite



double-sided geocomposite

- function is always in-plane flow rate capability

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This is the Essential Flow Rate Testing Device per ASTM D4716  
(more detail will come later)

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## An Important Conversion: “Flow Rate per Width (q/w)-to-Transmissivity (θ)”

- Uses conventional Darcy’s formula...

$$q = k i A$$

- From which,  $q = k i (w \times t)$   
 $q/w = i(k \times t)$   
 $q/w = i \theta$

$$\theta = \frac{q}{w} \frac{1}{i}$$

- Units of  $q/w$  and  $\theta$  are the same
- Values are equal only at  $i = 1.0$  which represents a vertical orientation
- For other orientations one can calculate  $\theta$  using the actual “ $i$ ”
- We focus on flow rate, rather than transmissivity, throughout the spec

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## Typical Biplanar Geonet Dimensions

- Thickness = 160 to 400 mil (4.1 to 10.2 mm)
- Width = 13 to 20 ft (4.0 to 6.0 m)
- Length = 200 to 300 ft (60 to 90 m)
- Factory rolled for shipment and delivery
- Geonets are not shipped in protective bags but geocomposites are bagged in thin plastic wrapper to protect the geotextiles from UV degradation

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## Test Properties Included on Spec

### Geonet (Before Lamination)

1. thickness
2. density
3. carbon black content
4. tensile strength
5. flow rate/width (with rigid end platens)

### Geotextile (Before Lamination)

6. mass/unit area
7. grab strength and elongation
8. tear strength
9. puncture strength
10. permittivity
11. apparent opening size
12. ultraviolet stability

### Geocomposite (Single and Double Sided)

13. flow rate/width (with flexible rubber end platens)
14. ply adhesion

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## 1. Thickness

- uses ASTM D5199
- specimen size is 2.0 in. (50 mm)
- applied pressure is 2.9 lb/in.<sup>2</sup> (20 kPa)
- ten specimens across the roll width
- frequency is every 50,000 lb (22,000 kg)

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Geonet Thickness  
per ASTM D5199



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## 2. Density

- uses ASTM D1505 (gradient column)
- or ASTM D792 (displacement)
- D1505 is more accurate, while D792 is more straightforward and easier
- “formulated” product value  $\geq 0.950$  g/cc
- frequency is every 50,000 lb (22,000 kg)

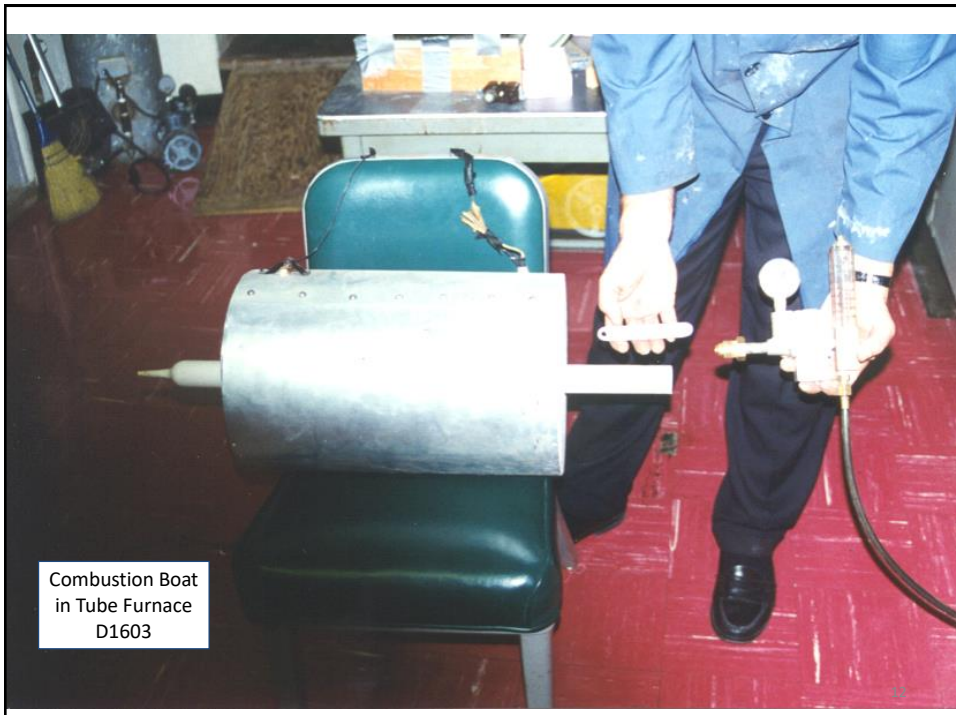
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### 3. Carbon Black Content

- uses ASTM D1603 (combustion boat placed in tube furnace)
- uses ASTM D4218 (muffle furnace)
- microwave oven is okay if correlation is established
- ave. of two tests must be in 2.0 to 3.0% range
- frequency is every 100,000 lb (45,000 kg)

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Combustion Boat  
in Tube Furnace  
D1603



## 4. Tensile Strength

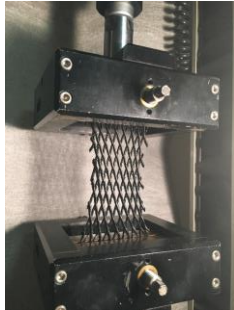
- uses ASTM D7179
- specimen size is 4.0 in. (100 mm) wide by 8.0 in. (200 mm) long... gage length is 4.0 in. (100 mm)
- CRE device speed is 12 in./min (300 mm/min)
- ave. of five tests; all in MD
- frequency is very 50,000 lb (22,000 kg)



## Geonet Tensile Test per ASTM D7179



(a) test at start



(b) test at midpoint



(c) test at failure

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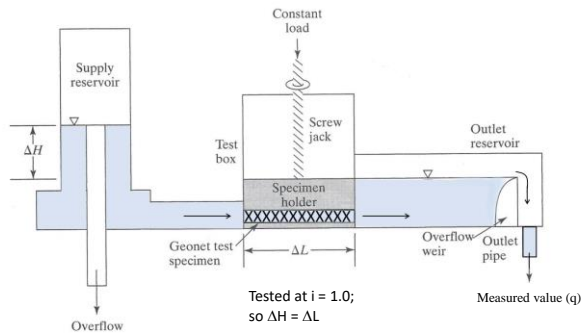
## 5. Flow Rate per Unit Width

- uses ASTM D4716
- specimen size is 12 in. (300 mm) wide by (typically) 14 in. (355 mm) long
- geonet by itself uses rigid platens top and bottom
- applied pressure is 10,000 lb/ft<sup>2</sup> (480 kPa)
- seating dwell time is 15 min.
- hydraulic gradient (i) is maintained at 1.0
- frequency is every 200,000 lb (90,000 kg)

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## Planar Flow Testing Device per D4716 Resulting in Flow Rate or Transmissivity



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## 6. Geotextile Mass per Unit Weight

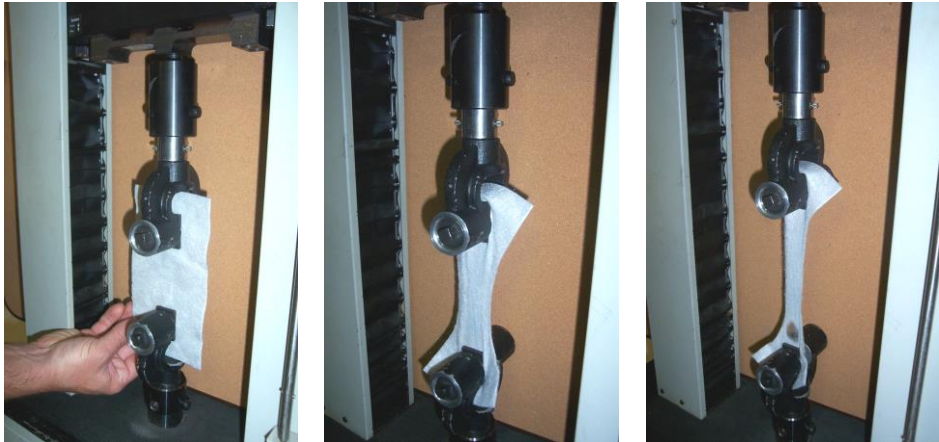
- generally referred to as “weight”
- follows ASTM D5261
- 5 specimens across roll width
- develop MARV to compare to spec
- spec lists 6.0 and 8.0 oz/yd<sup>2</sup> (200 and 270 g/m<sup>2</sup>) only... others are possible

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## 7. Geotextile Grab Strength and Elongation

- follows ASTM D4632
- 10 specimens MD & XMD across width
- 4.0 in. (100 mm) wide; gripped in center 1.0 in. (25 mm)
- must avoid slippage or grip failure
- record maximum strength in lb (kN)
- record elongation at max. strength
- $(\delta/L) 100 = \% \text{ elongation}$
- uses MARV for strength and elongation



D4632 - Grab Tensile Test  
(Evaluates Strength and Elongation at Failure)

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## 8. Geotextile Tear Strength

- follows ASTM D4533
- tear propagates from an initial cut
- maximum value is recorded
- 10 specimens in MD and XMD across roll width
- uses MARV and compare to specification

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D4533 - Trapezoidal Tear Strength  
(Measures the Maximum Value)

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## 9. Geotextile Puncture Strength

- California Bearing Ratio (CBR) is a soil strength test adopted for geosynthetics
- follows ASTM D6241 using the same device
- probe is 2.0 in. (50 mm) diameter
- container is 6.0 in. (150 mm) diameter
- 10 specimens across roll width
- strength and deformation monitored
- take average strength
- uses MARV and compare to spec

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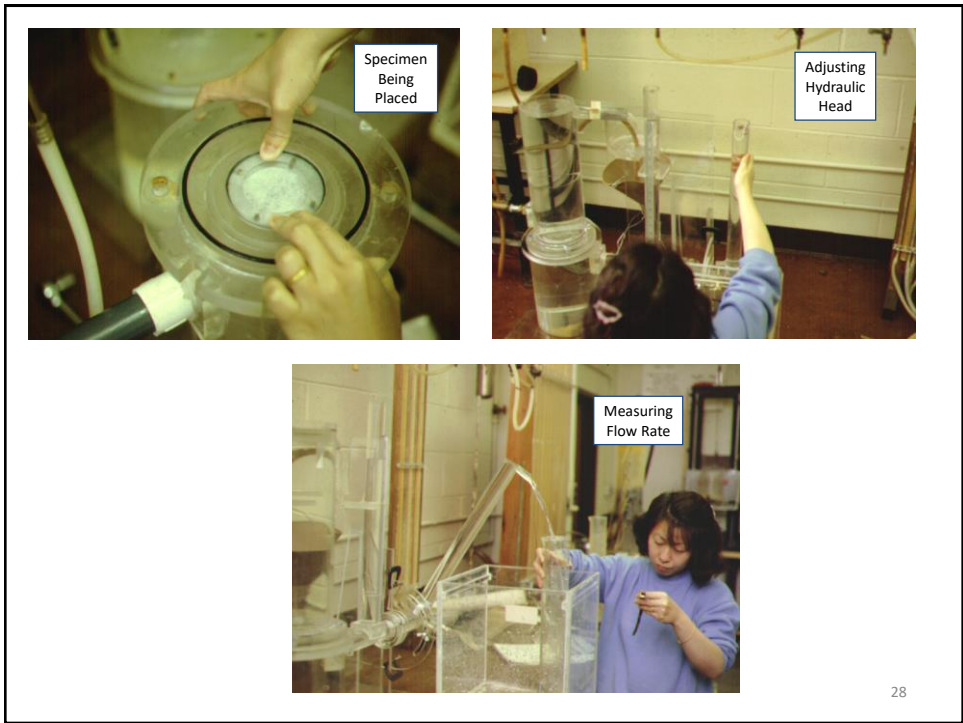
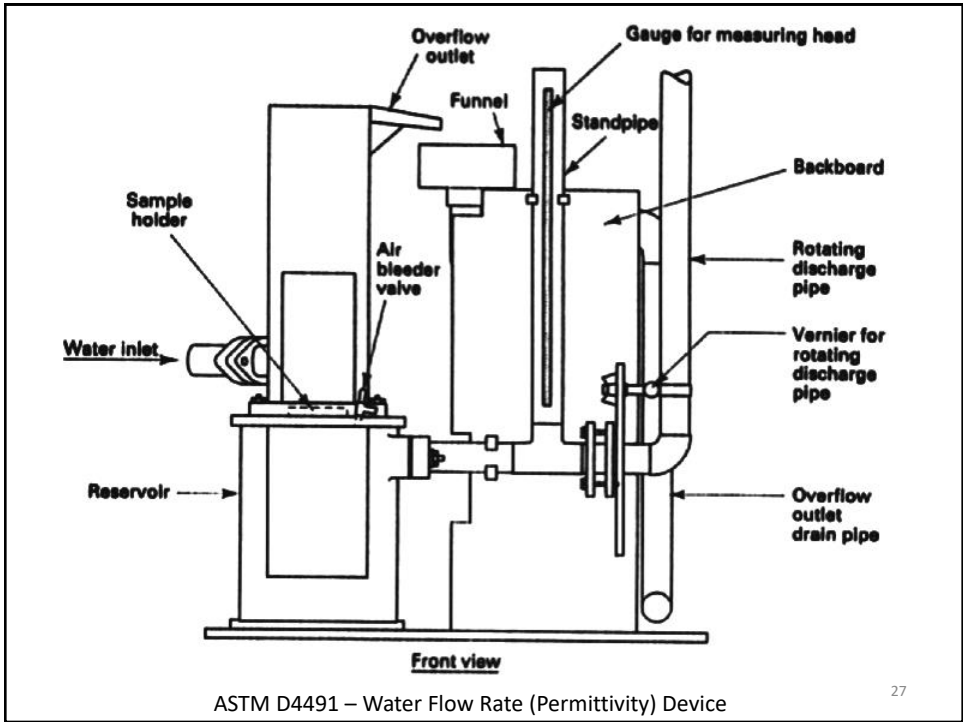
D6241 - Puncture (CBR) Strength  
(Measures Strength at Rupture and Accompanying Deformation)

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## 10. Geotextile Permittivity

- follows ASTM D4491
- uses deaired water ( $\leq 6$  ppm dissolved oxygen)
- measures flow rate at a constant head of 2.0 in. (50 mm)
- results in permittivity,  $\psi = (k)(t)$
- value must be  $\geq 0.02 \text{ sec}^{-1}$

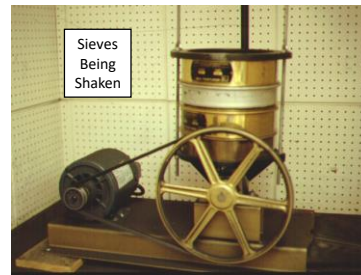
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## 11. Geotextile Apparent Opening Size

- its dry bead sieving, per ASTM D4751
- AOS is often called EOS
- it's a maximum value, i.e., "MaxARV"
- converted to either  $O_{95}$  in mm, or equivalent U. S. sieve size
- values must be  $\leq 0.001$  in. (0.25 mm)
- this is equivalent to #60 sieve size

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## 12. Geotextile Ultraviolet Stability

- follows ASTM D7238 (UV fluorescent tube method)
- cycled at 20 hrs. light; 4 hrs. dark with condensation
- 1.0 in. (50 mm) strip tensile test per D5035
- 5 MD and 8 XMD and values averaged
- 50% strength retained after 500 lt. hrs.

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## 13. Geocomposite Ply Adhesion

- uses ASTM D7005 to pull GT off of GN
- specimen size is 4.0 in. (100 mm) wide by 8.0 in. (200 mm) long... 4.0 in. (100 mm) between grips
- CRE device at 12 in./min (300 mm/min)
- ave. of five test; all in MD
- frequency is even 100,000 lb (45,000 kg)

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Ply Adhesion Test (ASTM D7005) at Midtest and Failure



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## 14. Geocomposite Flow Rate

- uses ASTM D4716
- same description as with Test #5
  - except -
- GT surface(s) are tested using flexible end platens per D4716 Section 6.1.6
- closed cell foam rubber is 0.25 in. (10 mm) thick above and/or below the geocomposite
- produces GT intrusion and lower flow rates

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Closed Cell Foamed Rubber Soft Boundary  
Simulating Soil Intrusion Effect  
(for double-sided composites use foamed rubber on both sides)



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## Regarding Individual Test Frequency

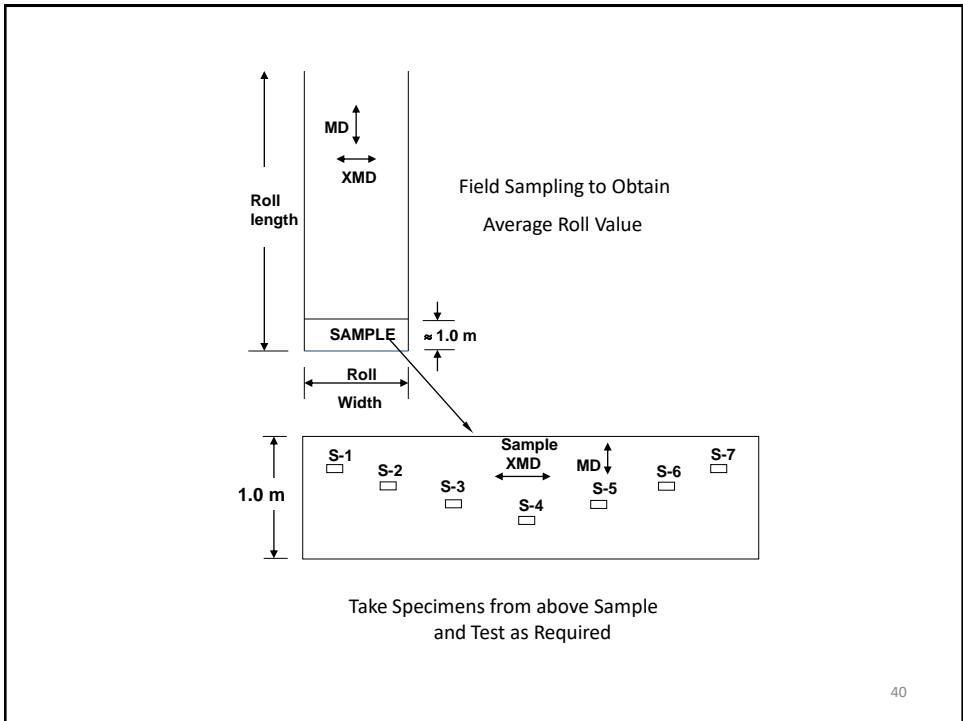
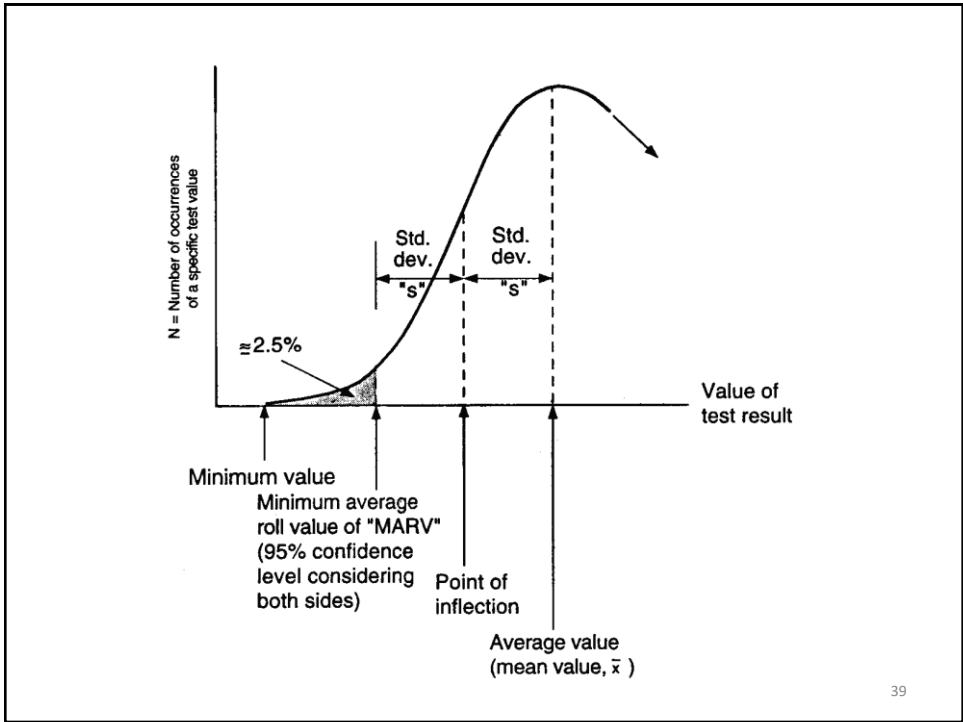
- geonet and geocomposite frequency per specific test method to obtain minimum average
- GT (by itself) is based on MARV, except AOS which is MaxARV (neither is used for UV stab.)
- MARV is a negotiated concept, but accepted throughout GT industry.. but only for GTs
- see following, but for complete details see GSI White Paper #10

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## Regarding MARV

- minimum average roll value
- accommodates variation in GT manufacturing properties
- statistically it's the " $\mu-2\sigma$ " value
- MaxARV is the " $\mu+2\sigma$ " value
- procedure shown in next screens

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Test Number	Roll Number					
	1	2	3	4	5	6
1	643N	627N	637N	642N	652N	637N
2	627	615	643	646	641	624
3	652	621	628	658	639	631
4	629	616	662	641	657	620
5	632	619	646	635	642	618
6	641	621	633	642	651	633
7	<u>662</u>	<u>622</u>	<u>619</u>	<u>658</u>	<u>641</u>	<u>641</u>
Average =	641	620	638	646	646	629

↑ This is the MARV Value!

U.S. (English) Units

Table 1(a) – MQC Specification for Biplanar Geonets and Geonet Composites

Property	Test Method	Test Value Based on Geonet Thickness						Test Frequency
		200 mil		250 mil		300 mil		
<b>(a) Geonet (before lamination)</b>								
Thickness <sup>(1)</sup> , mils (min. ave.)	D5199	200		250		300		per 50,000 lb.
Density <sup>(2)</sup> , g/cc (min. ave.)	D1505/D792	0.95		0.95		0.95		per 50,000 lb.
Carbon Black Content, % (range)	D1603/D4218	1.5 to 3.0		1.5 to 3.0		1.5 to 3.0		per 100,000 lb.
Tensile Strength <sup>(3)</sup> , lb. (min. ave.)	D7179	180		240		300		per 50,000 lb.
Flow Rate/Width <sup>(4)</sup> , gal/min-ft (min. ave.)	D4716	5.0		7.2		9.0		per 200,000 lb.
<b>(b) Geotextile (before lamination)<sup>(5)</sup></b>								
Mass/Unit Area, oz/sy (MARV)	D5261	6	8	6	8	6	8	Note (6)
Grab Strength, lb (MARV)	D4632	157	200	157	200	157	200	
Grab Elongation, % (MARV)	D4632	50	50	50	50	50	50	
Tear Strength, lb (MARV)	D4533	55	80	55	80	55	80	
Puncture Strength, lb (MARV)	D4833	55	80	55	80	55	80	
Permittivity, sec <sup>-1</sup> (MARV)	D4491	0.2	0.2	0.2	0.2	0.2	0.2	
AOS, mm (MaxARV)	D4751	0.25	0.25	0.25	0.25	0.25	0.25	
UV Stability, % ret. (500 hr.)	D4355	50	50	50	50	50	50	
<b>(c) Single-Sided Laminated Composite</b>								
Flow Rate/Width <sup>(4)</sup> , gal/min-ft (min. ave.)	D4716	2.7	2.2	3.9	3.2	4.9	4.0	per 200,000 lb.
Ply Adhesion <sup>(7)</sup> , lb/in. (min. ave.)	D7005	1.0	1.0	1.0	1.0	1.0	1.0	per 100,000 lb.
<b>(d) Double-Sided Laminated Composite</b>								
Flow Rate/Width <sup>(4)</sup> , gal/min-ft (min. ave.)	D4716	2.0	1.5	2.9	2.2	3.6	2.7	per 200,000 lb.
Ply Adhesion <sup>(7)</sup> , lb/in. (min. ave.)	D7005	1.0	1.0	1.0	1.0	1.0	1.0	per 100,000 lb.

- (1) The diameter of the presser foot shall be 2.22 in. and the pressure shall be 2.9 lb/in<sup>2</sup>.
- (2) Density is of the formulated material; the base resin will be slightly lower.
- (3) This is the average peak value for five equally spaced machine direction tests across the roll width.
- (4) Geonets shall be tested between rigid end platens at a hydraulic gradient of 1.0 (hence, this is also the "transmissivity"); a pressure of 10,000 lb/ft<sup>2</sup>, and a seating dwell time of 15 min. If specimen is a geocomposite, the geotextile side(s) shall be tested using flexible boundaries. Test values are for machine direction only.
- (5) These values are Class 1 and Class 2 of the AASHTO M288-00 specification for drainage (filtration) requirements of 15 to 50% fines passing #200 sieve. Generally, one or the other will be used.
- (6) Since these geotextile values are MARV, the statistics needed to obtain such values dictate the frequency of testing.
- (7) This is the average of five equally spaced machine direction tests across the roll width of the single-sided geocomposite. Both sides should be tested for the double-sided geocomposite.

Table 1(b) – MQC Specification for Biplanar Geonets and Geonet Composites

Property	Test Method	Test Value Based on Geonet Thickness			Test Frequency			
		5.0 mm	6.3 mm	7.6 mm				
<b>(a) Geonet (before lamination)</b>								
Thickness <sup>(1)</sup> , mm (min. ave.)	D5199	5.1	6.3	7.6	per 22,000 kg			
Density <sup>(2)</sup> , g/cc (min. ave.)	D1505/D792	0.95	0.95	0.95	per 22,000 kg			
Carbon Black Content, %	D1603/D4218	1.5 to 3.0	1.5 to 3.0	1.5 to 3.0	per 45,000 kg			
Tensile Strength <sup>(3)</sup> , kN (min. ave.)	D7179	0.79	1.05	1.31	per 22,000 kg			
Flow Rate/Width <sup>(4)</sup> , l/min-m (min. ave.)	D4716	62	89	111	per 90,000 kg			
<b>(b) Geotextile (before lamination)<sup>(5)</sup></b>								
Mass/Unit Area, g/m <sup>2</sup> (MARV)	D5261	200	270	200	270	Note (6)		
Grab Strength, N (MARV)	D4632	700	890	700	890	700	890	
Grab Elongation, % (MARV)	D4632	50	50	50	50	50	50	
Tear Strength, N (MARV)	D4533	240	350	240	350	240	350	
Puncture Strength, N (MARV)	D4833	240	350	240	350	240	350	
Permittivity, sec <sup>-1</sup> (MARV)	D4491	0.2	0.2	0.2	0.2	0.2	0.2	
AOS, mm (MaxARV)	D4751	0.25	0.25	0.25	0.25	0.25	0.25	
UV Stability, % ret. (500 hr.)	D7238	50	50	50	50	50	50	
<b>(c) Single-Sided Laminated Composite</b>								
Flow Rate/Width <sup>(4)</sup> , l/min-mm (min. ave.)	D4716	34	28	49	40	61	50	per 90,000 kg
Ply Adhesion <sup>(7)</sup> , N/m <sup>2</sup> (min. ave.)	D7005	170	170	170	170	170	170	per 45,000 kg
<b>(d) Double-Sided Laminated Composite</b>								
Flow Rate/Width <sup>(4)</sup> , l/min-mm (min. ave.)	D4716	25	19	36	27	44	33	per 90,000 kg
Ply Adhesion <sup>(7)</sup> , N/m (min. ave.)	D7005	170	170	170	170	170	170	per 45,000 kg

(1) The diameter of the presser foot shall be 56 mm and the pressure shall be 20 kPa.

(2) Density is of the formulated material; the base resin will be slightly lower.

(3) This is the average peak value for five equally spaced machine direction tests across the roll width.

(4) Geonets shall be tested between rigid end platens at a hydraulic gradient of 1.0 (hence, this is also the "transmissivity"); a pressure of 480 kPa, and a seating dwell time of 15 min. If specimen is a geocomposite, the geotextile side(s) shall be tested using flexible boundaries. Test values are for machine direction only.

(5) These values are Class 1 and Class 2 of the AASHTO M288-00 specification for drainage (filtration) requirements of 15 to 50% fines passing #200 sieve. Generally, one or the other will be used.

(6) Since these geotextile values are MARV, the statistics needed to obtain such values dictate the frequency of testing.

(7) This is the average of five equally spaced machine direction tests across the roll width of the single-sided geocomposite. Both sides should be tested for the double-sided geocomposite.