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Original: December 19, 2018

GRI-GS19 Standard*

Standard Specification for

"Test Methods, Required Properties and Testing Frequency for Geospacers and Geospacer Drainage Composites"

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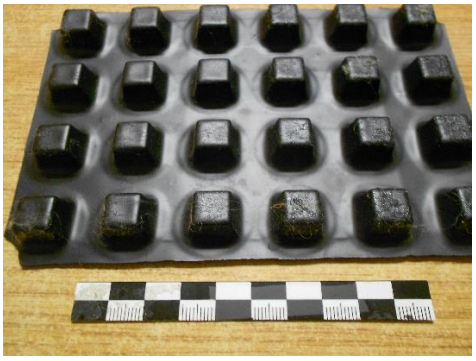
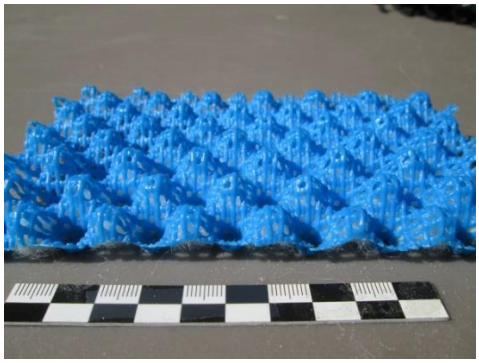
1. Scope

1.1 This generic specification covers geospacers and geospacer drainage composites (sometimes called drainage geocomposites) for subsequent use in transmitting liquids within the manufactured plane of the materials.

Note 1: Various types of currently available geospacer drainage cores (without their covering geotextiles) are shown in Figure 1.



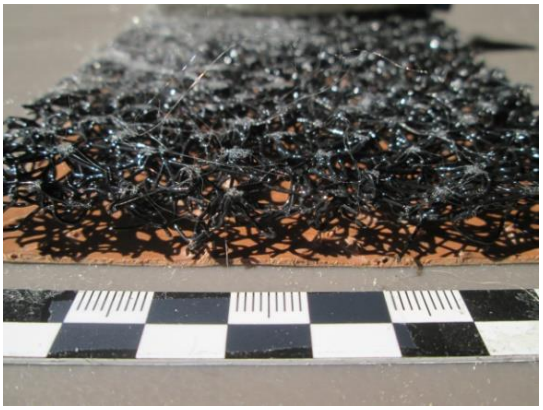
(a) Columns, or cones



(b) Cuspations

*This GRI standard specification is developed by the Geosynthetic Research Institute through consultation and review by the member organizations. This specification will be reviewed at least every 2-years, or on an as-required basis. In this regard it is subject to change at any time. The most recent revision date is the effective version and it is kept current on the Institute's Website <<geosynthetic.institute.org>>.

(c) Aligned W-channels



(d) 3-D mats

Figure 1. Various types of geospacer drainage cores.

Note 2: This specification does not cover biplanar or triplanar geonets or drainage composites made therefrom which are addressed in a separate specification; see GRI-GN4 in this regard.

1.2 This specification sets forth a set of physical, mechanical, hydraulic, and endurance properties that must be met, or exceeded by the product being manufactured.

Note 3: The specification is based on tap water being the transmitted liquid. It can be modified to accommodate other liquids as agreed upon by the parties involved.

Note 4: The focused flow parameter is flow rate per unit area under a given compressive stress and at a given hydraulic gradient. This experimental value can be used to calculate a transmissivity value (to be described later) as per request by the specifier or purchaser.

1.3 In the context of quality systems and management, this specification represents a manufacturing quality control (MQC) document.

Note 5: Manufacturing quality control represents those actions taken by a manufacturer to assure that a product represents the stated objective and properties set forth in the specification.

1.4 This standard specification is intended to assure good quality and performance of the geospacer and geotextile materials involved but is possibly not adequate for the complete specification in a specific situation. Additional tests, or more restrictive values for the tests indicated, may be necessary under conditions of a particular application.

1.5 This standard specification does not address manufacturing or installation practices. Both of these items are addressed in the literature by manufacturers dealing with these materials for a particular application.

2. Referenced Documents

2.1 ASTM Standards

D 4354 Practice for Sampling of Geosynthetics and Rolled Erosion Control (RECPs)
D 4491 Test Methods for Water Permeability of Geotextiles by Permittivity
D 4533 Test Method for Trapezoidal Tearing Strength of Geotextiles
D 4632 Test Method for Grab Breaking Load and Elongation of Geotextiles
D 4716 Test Method for Determining the (In-Plane) Flow Rate per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head
D 4751 Test Method for Determining Apparent Opening Size of a Geotextile
D 4873 Guide for Identification, Storage and Handling of Geosynthetic Rolls and Samples
D 5199 Test Method for Measuring the Nominal Thickness of Geosynthetics
D 5261 Test Method for Measuring Mass per Unit Area of Geotextiles
D 6241 Standard Test Method for Static Puncture Strengths of Geotextiles and Geotextile-Related Products Using a 50-mm Probe
D 6364 Standard Test Method for Determining Short-Term Compression Behavior of Geosynthetics
D 7005 Test Method for Determining the Bond Strength (Ply Adhesion) of Geocomposite
D7179 Standard Test Method for Determining Geonet Breaking Force

2.2 AASHTO Specification

M288-16 Geotextile Specification for Highway Applications

2.3 EPA Specification

U. S. EPA (1989), "Lining of Waste Containment and Other Impoundment Facilities" Cincinnati, Ohio, EPA/600/2-80/052

3. Definitions

3.1 Formulation - The mixture of a unique combination of ingredients identified by type, properties and quantity. For geospacers and geotextiles, a formulation is defined as the exact percentages and types of resin(s), additives and/or carbon black.

3.2 Manufacturing Quality Control (MQC) - A planned system of inspections that is used to directly monitor and control the manufacture of a material which is factory originated. MQC is normally performed by the manufacturer of geosynthetic

materials and is necessary to ensure minimum (or maximum) specified values in the manufactured product. MQC refers to measures taken by the manufacturer to determine compliance with the requirements for materials and workmanship as stated in certification documents and contract specifications [ref. EPA/600/R-93/182].

3.3 Minimum Average Roll Value (MARV) – For geotextiles, a manufacturing quality control tool used to allow manufacturers to establish published values such that the user/purchaser will have a 97.5% confidence that the property in question will meet published values. For normally distributed data, "MARV" is calculated as the typical value minus two (2) standard deviations from documented quality control test results for a defined population from one specific test method associated with one specific property.

3.4 Maximum Average Roll Value (MaxARV) – The complimentary values to MARV except now defining a maximum, rather than minimum, value.

4. Material Classification and Formulation

4.1 This specification covers various types of geospacer drainage cores. It also covers geospacer composites wherein a geotextile covers one, or both, surfaces of the drainage core.

Note 6: In a drainage geocomposite, the geospacer serves the primary function of in-plane drainage, whereas the geotextile(s) serves the dual functions of separation and filtration.

4.2 The geospacer drainage cores in this specification are made in various shapes and configurations from a variety of polymer types, e.g., polyethylene, polypropylene, polystyrene, nylon and possibly others. Furthermore, there are additives in the formulations, such as carbon black, colorants and antioxidants for protection during extrusion and long-term service performance. The specification is silent as to both the resin and additive types as well as the specific formulation.

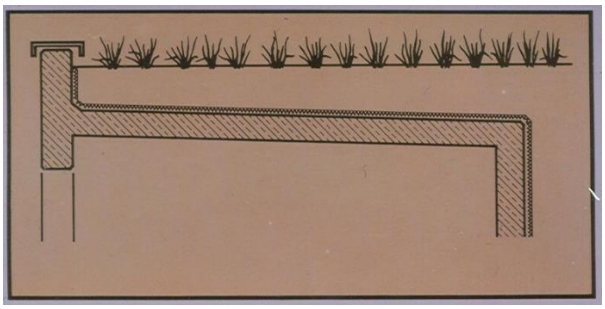
4.3 If reworked or post consumer resin is used it must be identified as to the origin of the material as well as the specific type and weight percentages added.

4.4 The geotextile that is commonly used for geospacer composites is a needle punched or heat bonded nonwoven polypropylene fabric bonded to the geonet core in the manufacturing facility.

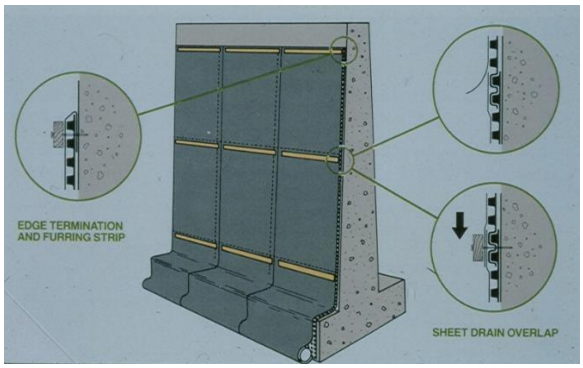
Note 7: The method of bonding the geotextile to the geospacer drainage core is usually by using a non-water soluable adhesive. If another method is used it must be identified as such.

5. Applications and Range of Behaviors

5.1 While there are myriad applications of geospacer composites, and occasionally the geospacer cores by themselves, the most common applications are illustrated in Figure 2 following.



(a) Green roof and plaza decks (comp. Ten Cate)



(b) Permanent retaining walls (comp. AWD Corp.)

(c) Temporary retaining walls (comp. J-Drain)

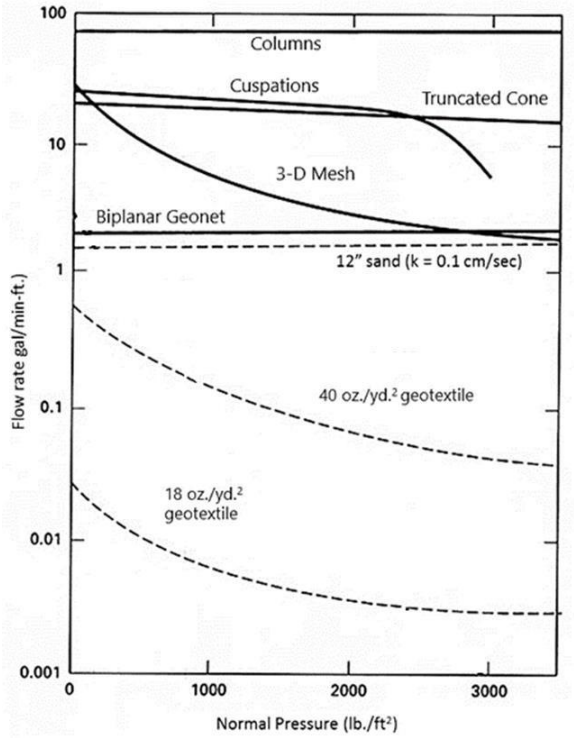
(d) Tunnels (comp. J-Drain)

Figure 2. - Typical applications of geospacer drainage composites.

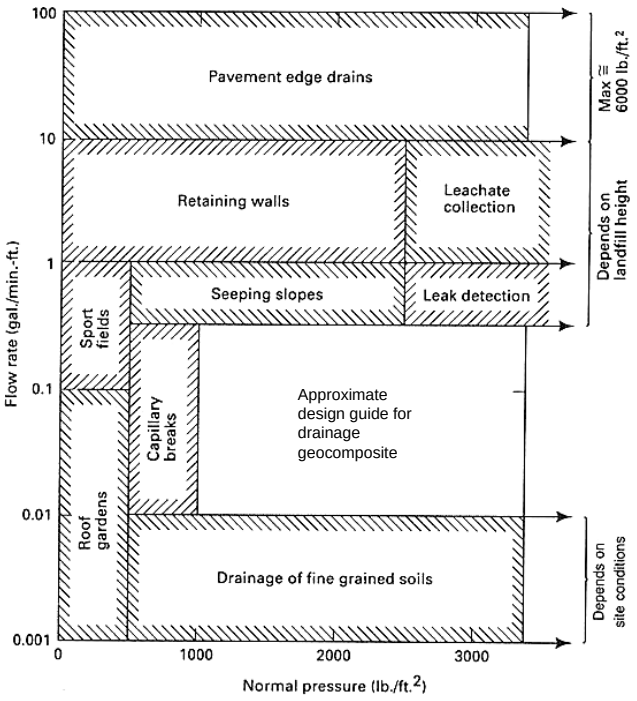
5.2 The inherent challenge in this particular specification is that the required flow rates as well as the associated normal compressive strengths vary greatly within the product type and specific application. Figure 3 shows such product behavior and the typical application requirements which can be served.

Note 8: For reference purposes, Figure 3(a) also indicates the flow rate of a sand drainage layer and a biplanar geonet to which these products are often compared.

Note 9: Figure 3(a) also shows the flow rate of two thick needle-punched nonwoven geotextiles; both of which are quite compressible and limited in their flow rate capacity compared to geospacer composites.



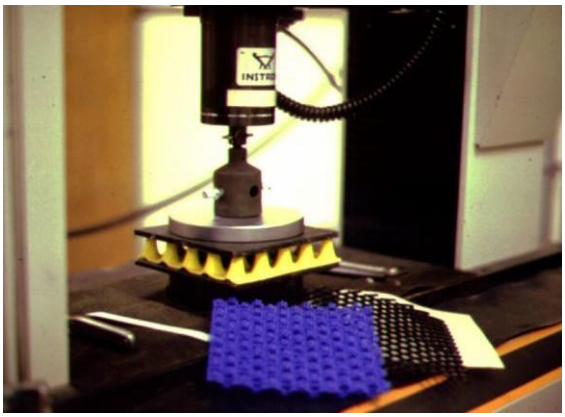
(a) Flow rate behavior of various geospacer composites and related drainage products



(b) Flow rate requirements of various engineering drainage applications

Figure 3. Flow rate behavior of various geospacer composites compared to sand layers, biplanar geonets and nonwoven geotextiles.
(ref. Designing With Geosynthetics, 3rd Ed., 1994, R. M. Koerner)

5.3 The two critical tests which are fundamental to this specification are the compressive strength and deformation per ASTM D6364 and the in-plane flow rate per ASTM D4716. They are shown in Figures 4 and 5, respectively. The very different behaviors shown in Figure 4 suggest that these products do indeed fall into application categories as indicated in Figure 3(b). Furthermore, the data indicated in Figure 3(a) is typically determined by a laboratory test device as shown in Figure 5.



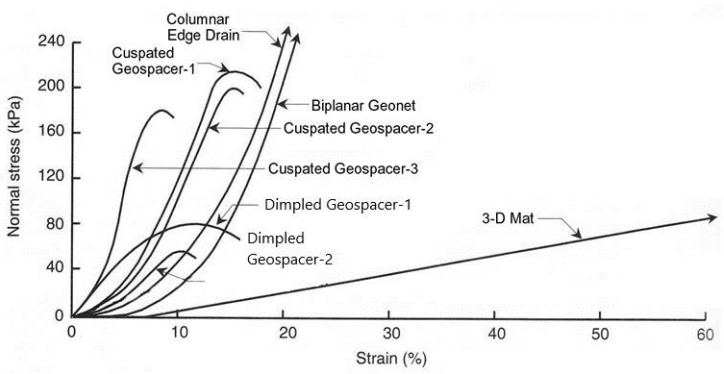


Figure 4. Compression test and typical response curves of several types of geospacer drainage cores per ASTM D6364, (comp., GSI).

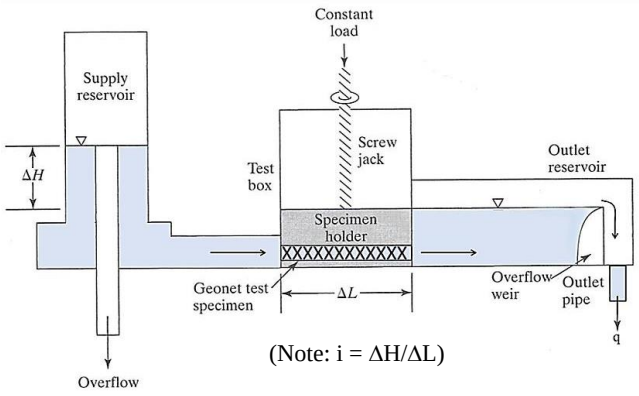


Figure 5. In-plane flow rate testing device per ASTM D4716, (comp., GSI).

6. Specification Requirements

6.1 The geospacer drainage cores, before attachment to geotextiles on one or both surfaces, should conform to Table 1 which is given in three different thickness ranges. Table 1(a) is given in U.S. (English) units and Table 1(b) is in S. I. (metric) units. The conversion from U. S. to S. I. units is "soft". The values listed are "minimum average".

Note 10: To obtain the minimum average value, the number of test values required by the respective standard is numerically averaged and the value must equal or exceed the listed specification value.

6.2 The geotextiles, before attachment to the geospacer cores (usually by bonding with a non-water soluable adhesive) shall conform to Table 1 which is given in two mass per unit area values.

6.3 In this specification, the geotextile properties follow the AASHTO M288-16 specification since it is used on a widespread basis in providing for separation and filtration functions. If the site-specific design calls for a different geotextile, or one with different properties, it must be communicated between the parties involved.

Note 11: Alternative geotextiles are different mass per unit area needle punched nonwovens, burnished needle punched nonwovens, heat-bonded nonwovens, slit-film wovens or monofilament wovens. Information is available from the respective manufacturers.

6.4 The geospacer-geotextile composite, sometimes called a geocomposite or even a drainage composite, with one or two geotextiles, (i.e., single-sided or double-sided) shall conform to Table 1. Both values listed, flow rate per width and ply adhesion, are minimum average values as described in Note 10. The flow rate tests are to be conducted with a flexible end platen against the geotextile surface(s).

Note 12: See ASTM D4716 Section 6.1.6 for a description of the flexible rubber boundary material to be used.

6.5 The tables for flow rate are given in units of gal/min-ft and l/min-m at a hydraulic gradient at 1.0. This value results directly from the requisite test procedure and is felt to be the intrinsic value under consideration, rather than the calculated transmissivity value.

Note 13: Since some owners and even regulators call for a value of transmissivity it can be reported accordingly. Flow rate (q) is converted to transmissivity (θ) as follows:

$$q = k\,i\,A \tag{1}$$

from which,

$$\begin{aligned} q &= k\,i\,(w \times t) \\ q/w &= i(k \times t) \\ q/w &= i\,\theta \\ \theta &= \left(\frac{q}{w}\right)\left(\frac{1}{i}\right) \end{aligned} \tag{2}$$

where

q = measured flow rate (l/min or gal/min)
k = hydraulic conductivity (aka, horizontal permeability)
i = hydraulic gradient (= $\Delta H/\Delta L$)
ΔH = difference between upstream and downstream heads
ΔL = test specimen length
w = test specimen width
t = test specimen thickness
q/w = flow rate per unit width (l/min-m or gal/min-ft)
θ = transmissivity (l/min-m or gal/min-ft)

6.6 The minimum frequency for testing of the geotextiles is given in Table 1. Alternatively, if the geotextile manufacturer can provide ongoing statistical data it is also acceptable. For example, use of minimum average roll values (MARV) [except for AOS which is MaxARV, and UV stability which is a minimum average value] are also acceptable.

7. Workmanship and Appearance

7.1 The finished geospacer or geospacer composite product shall have good appearance qualities. It shall be free from such defects that would affect the specific properties of the geotextile, or its proper functioning.

Note 14: For geospacer composites, there is typically unbonded geotextile of up to 12.0 in. (300 mm) beyond the sides of the geospacer core. This is good practice and helps to assure that complete coverage of the drainage core can be achieved in the field.

7.2 General manufacturing procedures shall be performed in accordance with the manufacturer's internal quality control guide and/or documents.

8. MQC Sampling, Testing, and Acceptance

8.1 Geospacers and geotextiles shall be subject to sampling and testing to verify conformance with this specification. In the absence of purchaser's testing, verification may be based on manufacturer's certifications as a result of testing by the manufacturer of quality assurance samples obtained using ASTM D4354; Sampling for Manufacturer's Quality Control (MQC) Testing.

Note 15: The geospacer core and the geotextile of a composite, once bonded together, do not maintain their original properties. The attachment process causes some amount of geotextile fiber breakage upon debonding. If original geospacer and geotextile properties are to be evaluated, testing shall be performed on the parent materials prior to the attachment process.

8.2 Testing shall be performed in accordance with the method referenced in this specification for the indicated application. The number of specimens to test per sample is specified by each test method.

8.3 In addition to the required tests and limiting values, Table 1 also provides minimum testing frequency for the various geonet and geocomposite properties. If the manufacturer's quality control documents are more restrictive, they shall apply.

9. MQC Retest and Rejection

9.1 If the results of any test do not conform to the requirements of this specification, retesting to determine conformance or rejection should be done in accordance with the manufacturing protocol as set forth in the manufacturer's quality control documents. In general, if any roll or panel fails only those bracketed by passing rolls or panels needs to be rejected.

10. Shipment and Storage

10.1 Geospacer and geospacer composite labeling, shipment, and storage shall follow ASTM D 4873. Product labels shall clearly show the manufacturer or suppliers name, style, and roll number. Each shipping document should include a notation certifying that the material is in accordance with this specification.

10.2 The geospacer composite rolls or panels shall be wrapped with a material that will protect the geotextile(s), including the ends of the roll, from damage due to shipment, water, sunlight and contaminants. The protective wrapping shall be maintained during periods of shipment and storage.

Note 16: Geospacer rolls or panels by themselves are generally not wrapped with a protective cover since the core itself is much less sensitive to ultraviolet degradation than the covering geotextile(s).

10.3 Geospacer and geospacer composites shall be elevated off the ground during storage. Alternatively, rolls can be stored on clean concrete or asphalt pavement without being elevated off the ground surface. In all cases, they should be adequately covered to protect them from the following; construction damage, precipitation, extended ultraviolet radiation including sunlight, chemicals that are strong acids or strong bases, flames including welding sparks, temperatures in excess of 160°F (71°C), root intrusion, and any other environmental condition that may damage the property values of the product involved.

11. Certification

11.1 The contractor shall provide to the engineer a certificate stating the name of the manufacturer, product name, style number, chemical composition of the geospacer and geotextiles involved, and other pertinent information to fully describe the product.

11.2 The manufacturer is responsible for establishing and maintaining a quality control program to assure compliance with the requirements of the specification. Documentation describing the quality control program shall be made available upon request.

11.3 The manufacturer's certificate shall state that the finished geospacer or geospacer composite meets minimum average values and the geotextile meets MARV requirements of the specification as evaluated under the manufacturer's quality control program. A person having legal authority to bind the manufacturer shall attest to the certificate.

11.4 Either mislabeling or misrepresentation of materials shall be reason to reject the products involved in this specification.

U. S. (English) Units

Table 1(a) – MQC Specification for Geospacer and Geospacer Composites

Property	Test Method	Test Values Based on Geospacer Thickness						Test Frequency
(a) Geospacer (before lamination)								
Thickness[(1)], in. (min. ave.)	D5199	< 0.33		0.33 to 0.67		> 0.67		per 50,000 lb.
Tensile Strength[(2)], lb. (min. ave.)	D7179	50		75		100		per 50,000 lb.
Compressive Strength[(3)], lb/ft.^{2} (min. ave.)	D6364	1000		1500		2000		per 100,000 lb
Flow Rate/Width[(4)], gal/min-ft (min. ave.)	D4716	10		15		20		per 200,000 lb.
(b) Geotextile (before lamination)[(5)]		–						
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)	D6241	310	430	310	430	310	430	
Permittivity, sec^{-1} (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	
(c) Single-Sided Laminated Composite								
Flow Rate/Width[(4)], gal/min-ft (min. ave.)	D4716	6.0		9.0		12		per 200,000 lb.
Ply Adhesion[(7)], lb./in. (min. ave.)	D7005	0.5		0.5		0.5		per 100,000 lb.
(d) Double-Sided Laminated Composite								
Flow Rate/Width[(4)], gal/min-ft (min.-ave.)	D4716	4.0		6.0		8.0		per 200,000 lb.
Ply Adhesion[(7)], lb./in. (min. ave.)	D7005	0.5		0.5		0.5		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^2.
(2) This is the average peak value for five equally spaced machine direction tests across the roll width.
(3) Test to be conducted using Section 6.2 fixed plates. Specified value is at 10% deformation.
(4) Geospacers shall be tested between rigid end platens at a hydraulic gradient of 1.0; a pressure of 1,000 lb./ft^2, and a seating dwell time of 15 min. If specimen is a geocomposite the geotextile side(s) should be tested using flexible boundaries against the geotextile(s). 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.

S. I. (Metric) Units

Table 1(b) – MQC Specification for Geospacer and Geospacer Composites

Property	Test Method	Test Value Based on Geonet Thickness						Test Frequency
(a) Geonet (before lamination)								
Thickness[1], mm (min. ave.)	D5199	< 8.4		8.4 to 17.0		> 17.0		per 22,000 kg
Tensile Strength[2], N (min. ave.)	D7179	220		340		450		per 22,000 kg
Compressive Strength[3], kPa (min. ave.)	D6364	48		72		95		per 45,000 kg
Flow Rate/Width[4], l/min-m (min. ave.)	D4716	120		180		240		per 90,000 kg
(b) Geotextile (before lamination)[5]								
Mass/Unit Area, g/m^2 (MARV)	D5261	200	270	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	250	350	250	350	250	350	
Puncture Strength, kN (MARV)	D6241	1.37	1.92	1.37	1.92	1.37	1.92	
Permittivity, sec^{-1} (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	
(c) Single-Sided Laminated Composite								
Flow Rate/Width[4], l/min-m (min. ave.)	D4716	73		109		146		per 90,000 kg
Ply Adhesion[7], N/m^2 (min. ave.)	D7005	88		88		88		per 45,000 kg
(d) Double-Sided Laminated Composite								
Flow Rate/Width[4], l/min-m (min.-ave.)	D4716	49		73		97		per 90,000 kg
Ply Adhesion[7], N/m (min. ave.)	D7005	88		88		88		per 45,000 kg

(1) The diameter of the presser foot shall be 56 mm and the pressure shall be 20 kPa.
(2) This is the average peak value for five equally spaced machine direction tests across the roll width.
(3) Test to be conducted using Section 6.2 fixed plates. Specified value is at 10% deformation.
(4) Geospacers shall be tested between rigid end platens at a hydraulic gradient of 1.0; a pressure of 48 kPa, and a seating dwell time of 15 min. If specimen is a geocomposite the geotextile side(s) should be tested using flexible boundaries against the geotextile(s). 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.