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Revision 4: July 9, 2020
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GRI-GN4 Standard[*]

Standard Specification for

"Test Methods, Required Properties and Testing Frequency for Biplanar Geonets and Biplanar Geonet Composites"

1. Scope

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

Note 1: This specification does not cover triplanar geonets or drainage composites made therefrom. It also does not cover the category of geosynthetic drainage materials called "geospacers".

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 2: 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.

[*]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>>.

Note 3: The focused flow parameter is flow rate per unit area. This experimental value can be used to calculate a transmissivity value 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 4: 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 geonet 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 installation practices or design guidance. Both of these items are addressed in the literature dealing with these materials in a particular application.

2. Referenced Documents

2.1 ASTM Standards

D 792 Test Methods for Density and Specific Gravity of Plastics by Displacement
D 1505 Test Method for Density of Plastics by the Density-Gradient Method
D 1603 Test Method for Carbon Black in Olefin Plastics
D 4218 Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique
D 4354 Practice for Sampling of Geosynthetics and Rolled Erosion Control (RECPs)
D 4355 Test Method for Deterioration of Geotextiles from Exposure to Ultraviolet Light and Water (Xenon-Arc Type Apparatus)
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 5035 Test Method for Breaking Force and Elongation of Textile Fabrics (Strip Method)
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
D7238 Standard Test Method for Effect of Exposure of Unreinforced Polyolefin Geomembranes Using Fluorescent UV Condensation Apparatus

2.2 AASHTO Specification

M288-16 Geotextile Specification for Highway Applications

3. Definitions

3.1 Formulation - The mixture of a unique combination of ingredients identified by type, properties and quantity. For geonets 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 geosynthetics, 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 geonets of the biplanar type. It also covers geonet composites wherein a geotextile covers one, or both, surfaces of the geonet.

Note 5: In a drainage geocomposite, the geonet serves the primary function of drainage, whereas the geotextile(s) serves the dual functions of separation and filtration.

4.2 The geonets covered in this specification are made from a formulation consisting of high density polyethylene (density ≥ 0.950 g/cc), in a weight percentage of approximately 97%, with about 2% carbon black, and the remainder being antioxidants for protection during extrusion and long-term service performance.

Note 6: The density of the base resin will be slightly lower, e.g., ≥ 0.940 g/cc, however, this is still in the category of high-density polyethylene (HDPE).

4.3 The resin shall be virgin material with no more than 25% rework. If rework is used, it must be a similar formulation as the parent material.

4.4 No post consumer resin (PCR) of any type shall be added to the formulation.

4.5 The type of geotextile is commonly a needle punched nonwoven polypropylene thermally bonded to the geonet core in the manufacturing facility.

4.6 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 7: Alternative geotextiles are burnished needle punched nonwovens (one or both sides), heat-bonded nonwovens, slit-film wovens or monofilament wovens.

5. Specification Requirements

5.1 The geonets, before lamination with geotextiles, shall conform to Table 1 which is given in three nominal thicknesses. Other thicknesses up to 400 mils (10.2 mm) are possible and information is available from the respective manufacturers. Table 1a is given in English units and Table 1b in S.I. units. The conversion from English to S.I. units is "soft". The values listed are "minimum average" values except for carbon black which is a range.

Note 8: 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.

5.2 The geotextiles, before lamination to the geonet, shall conform to Table 1 which is given in two mass per unit area values. Other mass per unit areas are possible and information is available from the respective manufacturers.

5.3 The geonet-geotextile composite (sometimes called a geocomposite) 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 8. The flow rate tests are to be conducted with a flexible end platen against the geotextile surfaces.

Note 9: See ASTM D5716 Section 6.1.6 for a description of the flexible rubber boundary material.

5.4 The tables for flow rate are given in units of gal/min-ft and l/min-m for 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 10: Since some specifications and even regulations 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)

5.5 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.

6. Workmanship and Appearance

6.1 The finished geonet or geonet 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 11: For geonet composites, there is typically unbonded geotextile of up to 12.0 in. (300 mm) on the sides of the geonet core. This is good practice and helps to assure that complete coverage of the geonet can be achieved in the field.

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

7. MQC Sampling, Testing, and Acceptance

7.1 Geonets and geotextiles shall be subject to sampling and testing to verify conformance with this specification, see Table 1. 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 12: The geonet and the geotextile of a composite, once heat bonded together, do not maintain their original properties. The thermal bonding process causes a slight reduction in the geonet thickness and is such that polymer embedment causes some amount of geotextile fiber breakage upon debonding. If original geonet and geotextile properties are to be evaluated, testing shall be performed on the parent materials prior to the lamination process.

7.2 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.

7.3 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.

8. MQC Retest and Rejection

8.1 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 fails only the roll bracketed by passing rolls needs to be rejected.

9. Shipment and Storage

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

9.2 Each geocomposite roll 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 13: Geonet rolls by themselves are generally not wrapped with a protective cover since the geonet itself is much less sensitive to ultraviolet degradation than the covering geotextile(s).

9.3 Geonet and geocomposite rolls 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.

10. Certification

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

10.2 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.

10.3 The manufacturer's certificate shall state that the finished geonet or geocomposite 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.

10.4 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 Biplanar Geonets and Geonet Composites

Property	Test Method	Test Value Based on Geonet Thickness						Test Frequency
(a) Geonet (before lamination)		**200 mil**		**250 mil**		**300 mil**		
Thickness[(1)], mils (min. ave.)	D5199	200		250		300		per 50,000 lb.
Density[(2)], 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[(3)], lb/in. (min. ave.)	D7179	45		60		75		per 50,000 lb.
Compressive Strength[(4)], lb/in.^{2} (min. ave.)	D6364	120		120		120		per 100,000 lb.
Flow Rate/Width[(5)], gpm/ft. (min. ave.)	D4716	5.0		7.2		9.0		per 200,000 lb.
(b) Geotextile (before lamination)[(7)]								
Mass/Unit Area, oz/sy (MARV)	D5261	6	8	6	8	6	8	Note (8)
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[(6)], gpm/ft. (min. ave.)	D4716	2.7	2.2	3.9	3.2	4.9	4.0	per 200,000 lb.
Ply Adhesion[(9)], lb/in. (min. ave.)	D7005	1.0	1.0	1.0	1.0	1.0	1.0	per 100,000 lb.
(d) Double-Sided Laminated Composite								
Flow Rate/Width[(6)], gpm/ft. (min.-ave.)	D4716	2.0	1.5	2.9	2.2	3.6	2.7	per 200,000 lb.
Ply Adhesion[(9)], 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^2.
(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) Test to be conducted using Section 6.3, the movable plate method.
(5) Geonets shall be tested for ASTM D4716 transmissivity between rigid end platens at a hydraulic gradient of 1.0 (hence, this is also the "transmissivity"); a pressure of 10,000 lb./ft^2, and at a seating dwell time of 15 min. Test values are for machine direction only.
(6) Single-sided or double-sided laminated composites shall be tested for ASTM D4716 transmissivity between a rigid platen bottom and a soft flexible boundary top that conforms to the ISO 12958 foam. It should be tested at a hydraulic gradient of 1.0, a pressure of 10,000 lb/ft^2, at a seating dwell time of 15 minutes and in the machine direction only.
(7) 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.
(8) Since these geotextile values are MARV, the statistics needed to obtain such values dictate the frequency of testing.
(9) 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 Biplanar Geonets and Geonet Composites

Property	Test Method	Test Value Based on Geonet Thickness						Test Frequency
(a) Geonet (before lamination)		**5.0 mm**		**6.3 mm**		**7.6 mm**		
Thickness[1], mm (min. ave.)	D5199	5.1		6.3		7.6		per 22,000 kg
Density[2], 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[3], kN/m (min. ave.)	D7179	7.9		10.5		13.1		per 22,000 kg
Compressive Strength[4], kPa (min. ave.)	D6364	830		830		830		per 45,000 kg
Flow Rate/Width[5], (l/min.)/m (min. ave.)	D4716	62		89		111		per 90,000 kg
(b) Geotextile (before lamination)[7]								
Mass/Unit Area, g/m^2 (MARV)	D5261	200	270	200	270	200	270	Note (8)
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[6], (l/min.)/m (min. ave.)	D4716	34	28	49	40	61	50	per 90,000 kg
Ply Adhesion[9], N/m (min. ave.)	D7005	170	170	170	170	170	170	per 45,000 kg
(d) Double-Sided Laminated Composite								
Flow Rate/Width[6], (l/min.)/m (min.-ave.)	D4716	25	19	36	27	44	33	per 90,000 kg
Ply Adhesion[9], 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) Test to be conducted using Section 6.3, the movable plate method.
(5) Geonet shall be tested for ASTM D4716 transmissivity between rigid end platens at a hydraulic gradient of 1.0 (hence, this is also the "transmissivity"); a pressure of 480 kPa, and at a seating dwell time of 15 min. Test values are for machine direction only.
(6) Single-sided or double-sided laminated composites shall be tested for ASTM D4716 transmissivity between a rigid platen bottom and a soft flexible boundary top that conforms to the ISO 12958 foam. It should be tested at a hydraulic gradient of 1.0, a pressure of 480 kPa, at a seating dwell time of 15 minutes and in the machine direction only.
(7) 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.
(8) Since these geotextile values are MARV, the statistics needed to obtain such values dictate the frequency of testing.
(9) 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.

Adoption and Revision Schedule for GRI-GN4

"Test Method, Required Properties and Testing Frequency for Biplanar Geonets and Biplanar Geonet Composites"

Adopted: October 3, 2018

Revision 1: November 28, 2018; Added compressive strength of geonet (by itself) per ASTM D6364
Revision 2: December 10, 2018; Corrected titles of mislabeled Tables 1 and 2
Revision 3: January 14, 2020; Updated and clarified units in Tables 1 and 2 on pages 8 and 9 respectively.
Revision 4: July 9, 2020; Updated footnote 5 in Tables 1 and 2 on pages 8 and 9 respectively in regards to a single not double soft "flexible" boundary on top only not bottom of the laminated composite (geocomposite) for ASTM D4716 transmissivity testing.