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Standard Guide for Specifying Drainage Geocomposites¹

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1. Scope

1.1 This guide presents a guideline specifying a drainage geocomposite product; it specifically provides recommendations to determine the allowable flow rate of a candidate drainage geocomposite. The resulting value is then compared to a required (or design) flow rate for a product-specific and site-specific factor of safety.

1.2 This guide is intended to aid designers, purchasers, installers, contractors, owners, operators, and agencies in establishing minimum guidelines for drainage geocomposite materials. This guide is not to be used for manufacturer's quality control purposes, nor a construction quality assurance specification.

1.3 This guide does not address the required (or design) flow rate value, nor the subsequent factor of safety values, which are typically design specific.

1.4 The procedures recommended in this guide use ASTM test methods.

1.5 This guide is applicable to all types of drainage geocomposites regardless of their core configuration or geotextile type. It can also be used to evaluate thick, nonwoven geotextiles that provide drainage.

1.6 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in nonconformance with the standard.

1.7 This guide offers an organized collection of information or a series of options and does not recommend a specific course of action. This guide cannot replace education or experience and should be used in conjunction with professional judgment. Not all aspects of this guide may be applicable in all circumstances. This guide is not intended to represent or replace the standard of care by which the adequacy of a given professional

¹ This guide is under the jurisdiction of ASTM Committee D35 on Geosynthetics and is the direct responsibility of Subcommittee D35.03 on Permeability and Filtration.

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service must be judged, nor should this guide be applied without consideration of a project's many unique aspects. The word 'standard' in the title of this guide means only that the guide has been approved through the ASTM International consensus process.

1.8 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.9 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 ASTM Standards:²

- D1987 Test Method for Biological Clogging of Geotextile or Soil/Geotextile Filters
- D2990 Test Methods for Tensile, Compressive, and Flexural Creep and Creep-Rupture of Plastics
- D4354 Practice for Sampling of Geosynthetics and Rolled Erosion Control Products (RECPs) for Testing
- D4439 Terminology for Geosynthetics
- D4716/D4716M Test Method for Determining the (In-plane) Flow Rate per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head
- D4873/D4873M Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples
- D5321/D5321M Test Method for Determining the Shear Strength of Soil-Geosynthetic and Geosynthetic-Geosynthetic Interfaces by Direct Shear
- D5322 Practice for Laboratory Immersion Procedures for Evaluating the Chemical Resistance of Geosynthetics to Liquids
- D6243/D6243M Test Method for Determining the Internal and Interface Shear Strength of Geosynthetic Clay Liner

² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

- by the Direct Shear Method
- D6388** Practice for Tests to Evaluate the Chemical Resistance of Geonets to Liquids
- D6389** Practice for Tests to Evaluate the Chemical Resistance of Geotextiles to Liquids
- D6747** Guide for Selection of Techniques for Electrical Leak Location of Leaks in Geomembranes
- D7001** Specification for Geocomposites for Pavement Edge Drains and Other High-Flow Applications
- D7273/D7273M** Guide for Acceptance Testing Requirements for Geonets and Geonet Drainage Geocomposites
- D7361** Test Method for Accelerated Compressive Creep of Geosynthetic Materials Based on Time-Temperature Superposition Using the Stepped Isothermal Method
- D7406** Test Method for Time-Dependent (Creep) Deformation Under Constant Pressure for Geosynthetic Drainage Products
- D7852** Practice for Use of an Electrically Conductive Geotextile for Leak Location Surveys

3. Terminology

3.1 Definitions:

3.1.1 For definitions of terms related to geosynthetics, refer to Terminology **D4439**.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *agency, n*—in geosynthetics, the organization that reviews the permit application for compliance with the agency's regulation and all quality assurance documentation before and after construction.

3.2.2 *contractor, n*—in geosynthetics, the party or organization that has the responsibility for the construction of the man-made project, structure, or system.

3.2.3 *designer, n*—in geosynthetics, the person or organization that designs a man-made project, structure, or system that fulfills the owner/operator's requirements and meets or exceeds the minimum requirements of the agency.

3.2.4 *installer, n*—in geosynthetics, the party that installs, or facilitates installation of, any materials purchased from manufacturers or suppliers.

3.2.5 *operator, n*—in geosynthetics, the person or organization that operates the man-made project, structure, or system.

3.2.6 *owner, n*—in geosynthetics, the person or organization that owns the man-made project, structure, or system.

3.2.7 *purchaser, n*—in geosynthetics, the person, company, or organization that purchases any materials or work to be performed.

3.2.8 q_{100} , *n*—initial flow rate for a drainage geocomposite as determined under simulated conditions for 100-h duration.

3.2.9 q_{allow} , *n*—allowable flow rate for a drainage geocomposite.

4. Significance and Use

4.1 This guide is intended to aid designers, purchasers, installers, contractors, owners, operators, and agencies in establishing the minimum criteria to specify drainage geocomposites. Specifically, this guide presents a methodology for

determining the allowable flow rate of a candidate drainage geocomposite. The resulting value is then compared to a required (or design) flow rate for a product-specific and site-specific factor of safety.

4.2 It is recognized that there are other products that may achieve the same performance requirements but are not listed in this document. Manufacturers of such products are invited to implement this standard guide with the appropriate information.

4.3 It should be recognized that parties, organizations, or representatives may perform additional tests other than those required in this guide. In this case, the more stringent project-specific tests will then take precedence.

4.4 By simulating site-specific conditions (inclusive of site-specific liquids and temperatures except for load duration beyond 100 h, chemical/biological clogging, and geotextile intrusion), additional reduction factors need not be explicitly accounted for in certain products.

5. Classification

5.1 *General*—This guide covers geocomposite drainage products or structures intended for blanket subsurface drainage applications. Five distinctly different product designs are included in this guide as geocomposite drainage products:

5.2 *Biaxial Geonet Geocomposite*—A geonet consisting of an integrally connected parallel set of ribs overlying a similar set of ribs at typically opposite angles, typically heat laminated with nonwoven geotextiles on the top and bottom to form the geocomposite. Note that single-sided biaxial geonet geocomposites are available in the marketplace as well; in that particular case, only one side of the geonet will be heat laminated with a nonwoven geotextile.

5.3 *Triaxial Geonet Geocomposite*—A geonet consisting of an integrally connected parallel set of ribs, or forming an integrated web with a flow direction mainly oriented in the machine direction, typically heat laminated with nonwoven geotextiles on the top and bottom to form the geonet geocomposite. It should be noted that single-sided triaxial geonet geocomposites are available in the marketplace as well; in that particular case, only one side of the geonet will be heat laminated with a nonwoven geotextile.

5.4 *Multilinear Drainage Geocomposite*—A manufactured product composed of a series of parallel single drainage conduits regularly spaced across its width sandwiched between two or more geosynthetics.

5.5 *Structured Geomembrane System*—A geomembrane with integrated drainage nubs, spikes, or both. The drainage nubs, when overlain or heat laminated by a filter fabric (heat burnished on one side), will form the structured geomembrane drainage geocomposite.

5.6 *Sheet Drain Geocomposite*—A three-dimensional structured core consisting of integrally connected voids, typically heat laminated with a nonwoven geotextile or monofilament filter either on the top or bottom (or both) to form the drainage geocomposite. It should be noted that single-sided sheet drain geocomposites are available in the marketplace as well; in that

particular case, only one side of the structure will be laminated with a nonwoven geotextile or monofilament filter geotextile.

5.7 Geocomposite Edge Drain—A geotextile wrapped around a structural polymer drainage core used for subsurface drainage applications in highway, turf, and environmental applications. The product is typically 1 in. (25 mm) thick and available in 6 in. (150 mm), 12 in. (300 mm), 18 in. (450 mm), 24 in. (600 mm), 30 in. (750 mm), and 36 in. (900 mm) widths.

6. Determination of the q_{allow} of a Candidate Drainage Geocomposite

6.1 Basic Formulation³—This guide is focused on determination of a q_{allow} value using the following formula:

$$q_{allow} = q_{100} \left[\frac{1}{RF_{CR} \times RF_{CC} \times RF_{BC} \times RF_{GI}} \right] \quad (1)$$

where:

- q_{allow} = allowable flow rate for a drainage geocomposite,
- q_{100} = initial flow rate determined under simulated conditions for 100-h duration,
- RF_{CR} = reduction factor for creep to account for long-term behavior,
- RF_{CC} = reduction factor for chemical clogging,
- RF_{BC} = reduction factor for biological clogging, and
- RF_{GI} = reduction factor for geotextile intrusion past the initial 100-h seating time.

NOTE 1—The value of q_{allow} is typically used to determine the product-specific and site-specific flow rate factor of safety as follows:

$$FS = \frac{q_{allow}}{q_{reqd}} \quad (2)$$

The value of q_{reqd} is a design issue and is not addressed in this guide. Likewise, the numeric value of the factor of safety is not addressed in this guide. Suffice it to say that, depending on the duration and criticality of the situation, FS values should be conservative unless experience allows otherwise.

6.2 Upon selecting the candidate drainage geocomposite product, one must obtain the 100-h duration flow rate according to the Test Method **D4716/D4716M** transmissivity test or other appropriate transmissivity test method such as Specification **D7001**, which is more appropriate for high-flow applications. (See **6.2.2** for more background on which transmissivity test method to select.) This establishes the base value to which drainage core creep beyond 100 h, clogging from chemicals and biological matter, and geotextile intrusion must be accounted for.

6.2.1 It is recognized that the default duration listed in Test Method **D4716/D4716M** is 15 min. This guide purposely requires that the test conditions be maintained for 100 h, and simulating site-specific loading and boundary conditions.

³ This guide is updated and modified from GRI-GC 8 “Determination of the Allowable Flow Rate of a Drainage Geocomposite” to reflect different products in the marketplace today. For referenced GRI standards, visit the GSI website, <http://www.geosyntheticinstitute.org/>, or contact GSI Customer Service at (610) 522-8440. GRI standards are developed by the Geosynthetics Research Institute through consultation and review by the member organizations.

6.2.2 While Test Method **D4716/D4716M** has historically been the “default” transmissivity test for geosynthetic drainage geocomposites, this transmissivity test method is limited to the size of the specimen being tested. Zimmel et al. (2011) identified that specimen size can significantly affect transmissivity tests performed in accordance with Test Method **D4716/D4716M**; however, recent research has shown that Test Method **D4716/D4716M** typically underestimates the actual flow rates at a certain hydraulic gradient (tested with a large-scale transmissivimeter), at least for unidirectional drainage geocomposites, and as a result Test Method **D4716/D4716M** transmissivity results are typically conservative.

6.2.3 Furthermore, standard engineering practice identifies that the transmissivity is only valid for laminar flow conditions, specifically when Darcy’s law is valid, and then the transmissivity is an intrinsic property of the product and not dependent on external conditions such as the hydraulic gradient. According to Darcy’s law, transmissivity should be a constant. However, transmissivity testing of drainage geocomposites has shown that transmissivity is not a constant, but is associated not only with the normal load but also with the hydraulic gradient and selected boundary conditions. In fact, transmissivity decreases as the hydraulic gradient increases, because of the development of turbulent flow conditions within the water path of the product being tested. Typically, for hydraulic gradients used in transmissivity tests (greater than 0.1), the flow is non-laminar for drainage geonets or drainage geonet geocomposites (Giroud et al., 2012). Therefore, the water flow rate of a drainage geocomposite can be better expressed as a discharge (flow rate) at a given hydraulic loss (van der Sluys and Dierickx, 1987) than as a transmissivity.⁴

6.3 Reduction Factor for Creep—This is a long-term (typically 10 000 h) compressive load test focused on the stability or deformation (or both) of the drainage core without the covering geotextiles. Stress orientation can be perpendicular or at an angle to the test specimen depending upon site-specific conditions.

6.4 Chemical/Biological Clogging—The issue of long-term reduction factors to account for clogging within the core space is a site-specific issue.

6.5 Chemical Resistance/Durability—This procedure results in a “go/no-go” decision as to potential chemical reactions between the permeating liquid and the polymers comprising the drainage core and geotextiles. The issue will be addressed in this guide but is not a reduction factor, per se.

7. Determination of the q_{100}

7.1 Using the Test Method **D4716/D4716M** transmissivity test under simulated field conditions, as stated below (unless otherwise agreed upon by the parties involved, such as potentially using Specification **D7001** for appropriate high-flow applications), determine the q_{100} flow rate of the drainage geocomposite under consideration.

⁴ Bourges-Gastaud, S., Blond, E., Touze-Foltz, N., “Multiscale Transmissivity Study of Drain-Tube Planar Geocomposites: Effect of Experimental Device on Test Representativeness,” *Geosynthetics International*, Vol 20, No. 3, 2013, pp. 119–128.