Designation: D 5101 – 01

Standard Test Method for Measuring the Soil-Geotextile System Clogging Potential by the Gradient Ratio[1]

This standard is issued under the fixed designation D 5101; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method covers a performance test applicable for determining the soil-geotextile system permeability and clogging behavior for cohesionless soils under unidirectional flow conditions.

1.2 The values stated in SI units are to be regarded as standard. The values in parentheses are for information only.

1.3 *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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

D 123 Terminology Relating to Textiles[2]

D 653 Terminology Relating to Soil, Rock, and Contained Fluids[3]

D 737 Test Method for Air Permeability of Textile Fabrics[2]

D 4354 Practice for Sampling of Geosynthetics for Testing[4]

D 4439 Terminology for Geosynthetics[4]

3. Terminology

3.1 *Definitions:*

3.1.1 *clogging potential*, *n—in geotextiles*, the tendency for a given fabric to lose permeability due to soil particles that have either lodged in the fabric openings or have built up a restrictive layer on the surface of the fabric.

3.1.2 *geotextile*, *n*—a permeable geosynthetic comprised solely of textiles.

3.1.3 *gradient ratio*, *n—in geotextiles*, the ratio of the hydraulic gradient through a soil-geotextile system to the hydraulic gradient through the soil alone.

3.1.4 *hydraulic gradient, i, s (D)*—the loss of hydraulic head per unit distance of flow, dH/dL.

3.1.5 For definitions of other textile terms, refer to Terminology D 123. For definitions of other terms related to geotextiles, refer to Terminology D 4439 and Terminology D 653.

3.2 *Acronyms:*Symbols and Acronyms:

3.2.1 CO_2—the chemical formula for carbon dioxide gas.

3.2.2 *CHD*—the acronym for constant head device.

4. Summary of Test Method

4.1 This test method requires setting up a cylindrical, clear plastic permeameter (see Fig. 1 and Fig. 2) with a geotextile and soil, and passing water through this system by applying various differential heads. Measurements of differential heads and flow rates are taken at different time intervals to determine hydraulic gradients. The following test procedure describes equipment needed, the testing procedures, and calculations.

5. Significance and Use

5.1 This test method is recommended for evaluating the performance of various soil-geotextile systems under controlled test conditions. Gradient ratio values obtained may be plotted and used as an indication of the soil-geotextile system clogging potential and permeability. This test method is not appropriate for initial comparison or acceptance testing of various geotextiles. The test method is intended to evaluate geotextile performance with specific on-site soils. It is improper to utilize the test results for job specifications or manufacturers' certifications.

5.2 It is important to note the changes in gradient ratio values with time versus the different system hydraulic gradients, and the changes in the rate of flow through the system (see Section 11 and Annex A1.).

6. Apparatus and Supplies

6.1 *Soil-Geotextile Permeameter*—(three-piece unit) equipped with support stand, soil-geotextile support screen, piping barriers (caulk), clamping brackets, and plastic tubing (see Fig. 2). Both 100-mm (4-in.) and 150-mm (6-in.) diameter permeameters are described.

6.2 *Two Constant Water Head Devices*, one mounted on a jack stand (adjustable) and one stationary (Fig. 3).

[1] This test method 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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[2] *Annual Book of ASTM Standards*, Vol 07.01.

[3] *Annual Book of ASTM Standards*, Vol 04.08.

[4] *Annual Book of ASTM Standards*, Vol 04.13.

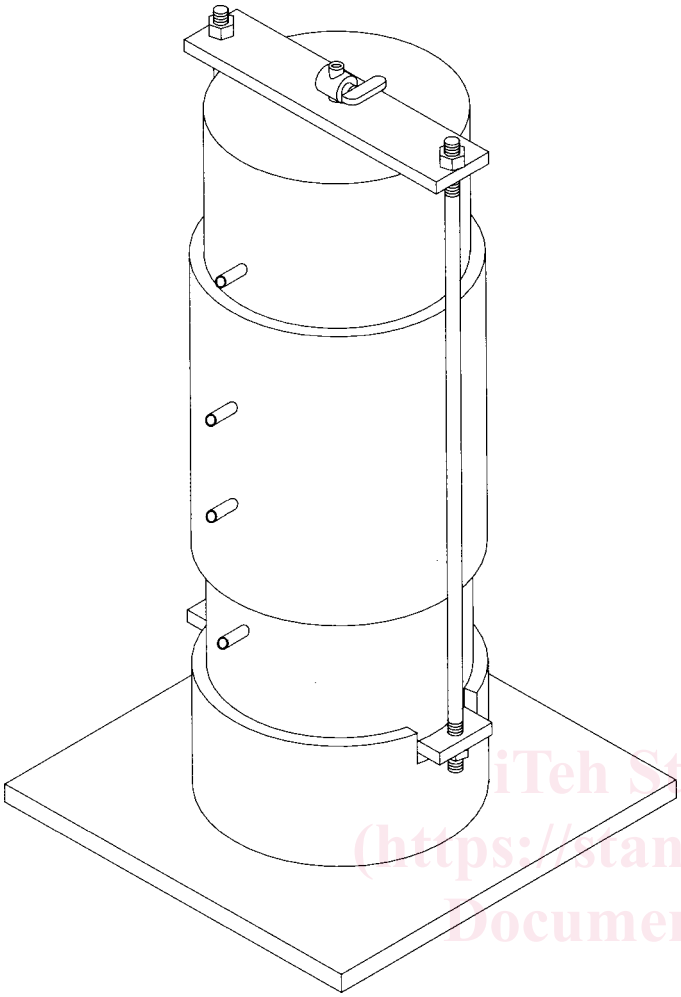

FIG. 1 Geotextile Permeameter

6.3 *Soil Leveling Device* (Fig. 4).

6.4 *Manometer Board*, of parallel glass tubes and measuring rulers.

6.5 *Two Soil Support Screens*, of approximately 5 mm (No. 4) mesh.

6.6 *Soil Support Cloth*, of 150 μm (No. 100) mesh, or equivalent geotextile.

6.7 *Thermometer* (0 to 50 ± 1°C).

6.8 *Graduated Cylinder*, 100 ± 1 cm^3 capacity.

6.9 *Stopwatch*.

6.10 *Balance*, or scale of at least 2-kg capacity and accurate to ±1 g.

6.11 *Carbon Dioxide*, (CO_2), gas supply and regulator.

6.12 *Geotextile*.

6.13 *Water Recirculation System*.

6.14 *Water Deairing System*, with a capacity of approximately 1700 L/day (500 gal/day).

6.15 *Algae Inhibitor*, or micro screen.

6.16 *150-μm Mesh Screen, (No. 100)*, or equivalent geotextile for manometer ports.

6.17 *Soil Sample Splitter (optional)*.

6.18 *Pan*, for drying soil.

6.19 *Mortar and Pestle*, for pulverizing soil.

6.20 *Wooden rod*, 20-mm (¾– in.) diameter by 150 mm (6 in.) long.

7. Sampling and Test Specimens

7.1 *Lot Sample and Laboratory Sample*—Take a lot sample and laboratory samples as directed in Practice D 4354. For laboratory samples, take a full width swatch of geotextile from each roll of material in the lot sample at least 1 m (3 ft) long cut from the end of the roll after discarding the first metre of material from the outside of the roll.

7.2 *Test Specimen*—Cut one circular specimen from each swatch in the laboratory sample with the specimen having a diameter of 110 mm (4.33 in.) or 165 mm (6.50 in.). Take the specimen from the center of the swatch.

8. Conditioning

8.1 *Test Water Preparation*:

8.1.1 Test water should be maintained at room temperature about 16 to 27°C (60 to 80°F), and deaired to a dissolved oxygen content of 6 parts per million (ppm) or less before introducing it to permeameter system. This will reduce or eliminate the problems associated with air bubbles forming within the test apparatus.

8.1.2 An algae inhibitor or micro screen should be used to eliminate any algae buildup in the system.

8.2 *Specimen Conditions*:

8.2.1 Condition the specimen by soaking it in a container of deaired water for a period of 2 h. Dry the surface of the specimen by blotting prior to inserting in the permeameter.

9. Procedure

9.1 *Preparation of Apparatus*:

9.1.1 Thoroughly clean and dry permeameter sections.

9.1.2 Close all valves and cover the inside openings of all manometer ports with fine wire mesh or lightweight nonwoven fabric (the equivalent of No. 100 mesh).

9.1.3 Lubricate all O-ring gaskets.

9.2 *Permeameter Preassembly*:

9.2.1 Stand center section of the permeameter on end and place a soil support cloth 110 mm (4.33 in.) or 165 mm (6.5 in.) in diameter on recessed permeameter flanges.

9.2.2 Insert the support screen 110 mm (4.33 in.) or 165 mm (6.5 in.) in diameter on top of the support cloth with the mesh side against the cloth.

9.2.3 Align and insert top section of the permeameter into center section and press until there is a tight fit to secure the support cloth and screen in place. Ensure that all gasket edges secure against the support cloth, support bracket, and between the center and top permeameter sections.

9.2.4 Invert and place permeameter into holding stand.

9.3 *Process Soil*:

The test is to be performed on minus ⅜in. material. The material passing the ⅜in. and retained on the No. 10 sieve is subject to a second round of grinding to ensure that the sample has been broken down into individual grains.

9.3.1 Thoroughly air dry the soil sample as received from the field. This shall be done for a minimum of three days. Grind the sample in a mortar with a rubber-tipped pestle (or in some

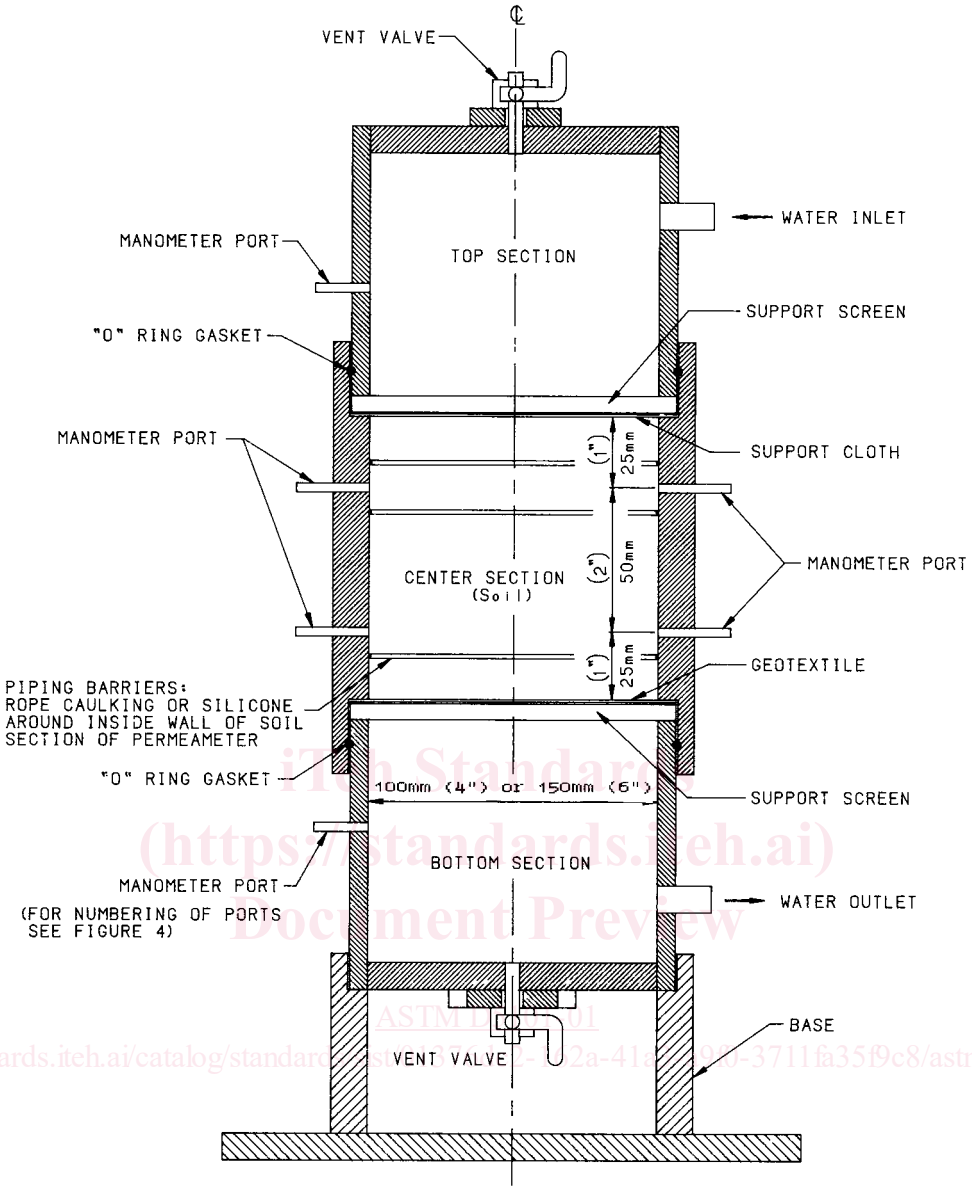

FIG. 2 Section—Geotextile Permeameter

other way that does not cause breakdown of individual grains), to reduce the particle size to a maximum of 10 mm (⅜ in.). Select a representative sample of the amount required (approximately 1350 (or 3000 g for the 150-mm (6-in.) diameter) to perform the test by the method of quartering or by the use of a soil splitter.

9.3.2 Select that portion of the air-dried sample selected for purpose of tests and record the mass as the mass of the total test sample uncorrected for hygroscopic moisture. Separate the test sample by sieving with a 2-mm (No. 10) sieve. Grind that fraction retained on the 2-mm (No. 10) sieve in a mortar with a rubber-covered pestle until the aggregations of soil particles are broken up into the separate grains.

9.3.3 Mix the fractions passing the 2-mm (No. 10) sieve along with the portion that was retained on the 2-mm (No. 10) sieve to form the test soil. All particles larger than 10 mm (⅜ in.) should be eliminated.

9.4 *Soil Placement*—The following procedures offer two options to the user. The first is a "standard" placement while the second is a "field condition" placement. The placement procedure is a critical aspect of the test and may significantly influence the test results.

9.4.1 *Standard Placement Method*:

9.4.1.1 Weigh out approximately 1350 g of air–dried processed soil (or 3000 g for the 150-mm (6-in.) diameter).

9.4.1.2 Place air– dried processed soil above the support cloth to a depth of 103 mm (4.12 in.). The final depth of soil after settlement will be approximately 100 mm (4 in.). The soil should be placed in 25- mm (1-in.) to 40-mm (1½-in.) layers, making sure that no voids exist along the permeameter walls at manometer ports, or the caulk piping barriers. The soil shall be placed carefully into the permeameter with a scoop or appropriate tool with a maximum drop of the soil no greater than 25 mm (1 in.). Consolidation of each layer shall consist of tapping

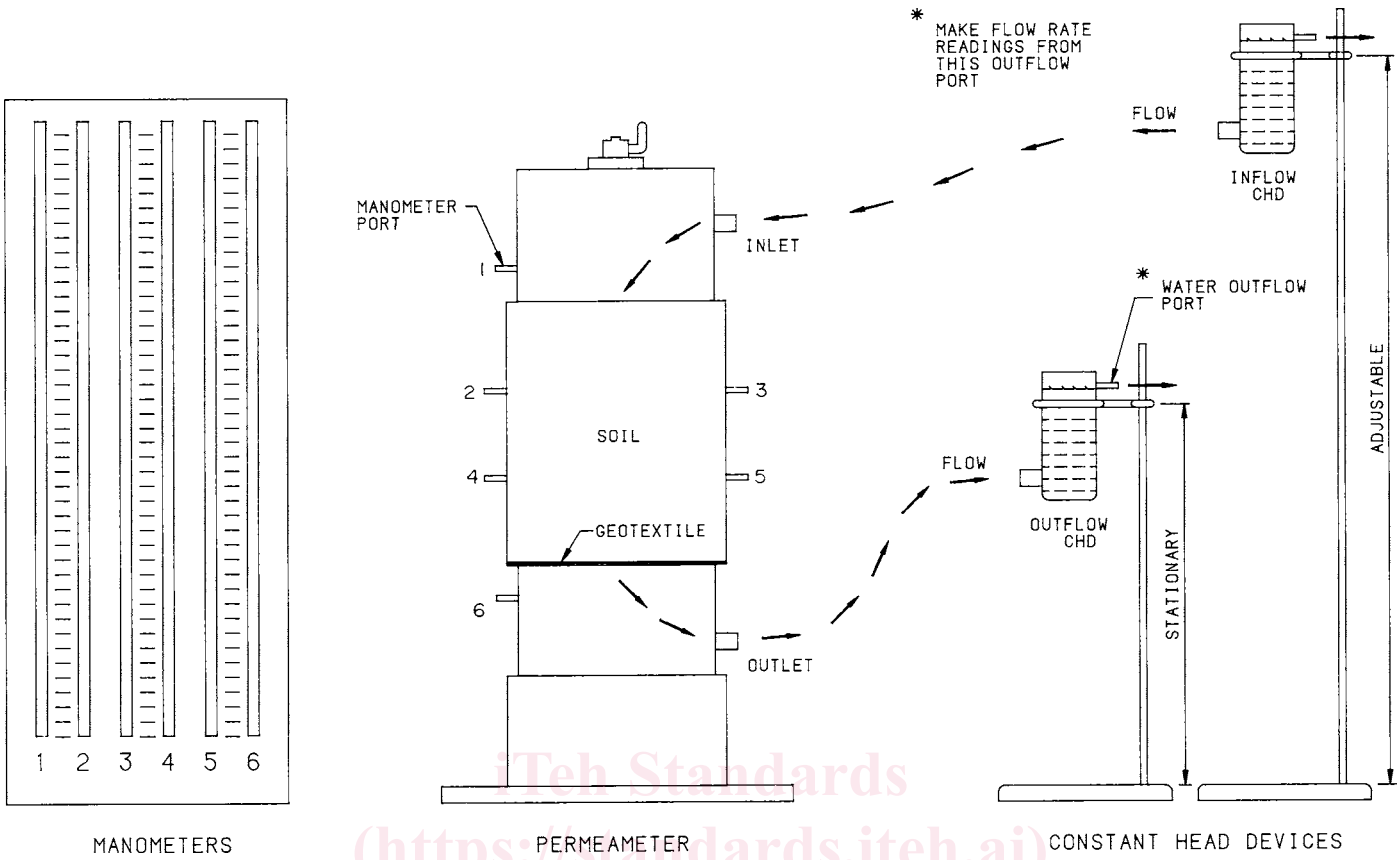

FIG. 3 Geotextile Permeameter "Set Up" Diagram

the side of the permeameter six times with a wooden rod, 20 mm (¾ in.) by 150 mm (6 in.) in diameter.

9.4.1.3 When the level of the soil in the permeameter reaches a depth of 100 mm (4 in.), insert the soil leveling device (Fig. 4), with the notch down, on the top edges of the permeameter. Continue placing soil and rotating the leveling device until the total soil height of 103 mm (4.12 in.) is reached.

9.4.1.4 Remove the soil leveler and any excess soil. Determine the mass of the soil in the permeameter for unit weight calculations.

NOTE 1—The standard soil placement procedure results in a relatively loose soil condition and is conservative for many applications. If a density approximating actual field soil conditions is desirable, the field condition procedure should be used. It should be recognized, however, that predicting field soil conditions may be very difficult due to construction installation procedures that generally disturb and loosen soils adjacent to the geotextile.

9.4.2 *Field Condition Soil Placement Method*:

9.4.2.1 Based on the desired field dry density, weigh out the processed dry soil required to achieve the target dry density in the permeameter used with a 100 mm (4 in) soil height.

9.4.2.2 Place the dry soil in four one-inch lifts using the end of the wooden dowel to compact the soil, making sure that no voids exist along the permeameter walls at the manometer ports or the caulk piping barriers.

9.4.2.3 Fill the permeameter to achieve the soil height of 100 mm (4 in). Determine the mass of soil used for unit weight calculations.

NOTE 2—Should the target density be unachievable without increasing the compaction effort, record the density actually achieved. While the looser condition may be somewhat more conservative, the dry placement and CO_2 purge are considered critical to reliable results.

9.5 *Permeameter Assembly and Setup*:

9.5.1 Clean the inner flange of the center section of the permeameter and insert the geotextile to be tested.

9.5.2 Insert the support screen on top of the geotextile with the mesh side against the geotextile.

9.5.3 Align and insert the bottom section of the permeameter into the center section and press tightly to secure the geotextile and support screen. The soil will compress from 103 mm (4.12 in.) to approximately 100 mm (4 in.) when the bottom section is secured. Check gaskets to ensure contact is made between permeameter sections, support screen, and geotextile.

9.5.4 Secure the permeameter sections together within clamp brackets and tighten bolts on bracket rods evenly.

9.5.5 Invert permeameter into holding stand so that the geotextile will be below the soil level.

9.5.6 Connect the inflow and outflow constant head devices (CHD) to their corresponding permeameter ports (see Fig. 3) with plastic tubing. The outflow CHD is attached to the bottom permeameter port and the inflow CHD is attached to the top permeameter port.

9.5.7 Connect all manometer tubes (1 through 5) to their corresponding permeameter manometer ports, and all overflow tubes to their corresponding outlet ports.

9.6 *Saturating the Soil/Geotextile System*: