



Standard Test Method for Determining Filtering Efficiency and Flow Rate of a Geotextile for Silt Fence Application Using Site-Specific Soil¹

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1. Scope

1.1 This test method is used to determine the filtering efficiency and the flow rate of a geotextile used exclusively in silt fence or silt barrier application.

NOTE 1—The terms silt fence and silt barrier are used synonymously.

1.1.1 The results are shown as a percentage for filtering efficiency and cubic metres per square metre per minute ($\text{m}^3/\text{m}^2/\text{min}$) or gallons per square foot per minute ($\text{gal}/\text{ft}^2/\text{min}$) for flow rate.

1.1.2 The filtering efficiency indicates the percent of sediment removed from sediment-laden water.

1.1.3 The flow rate is the average rate of passage of the sediment-laden water through the geotextile.

1.2 This test method requires several specialized pieces of equipment, such as an integrated water sampler and an analytical balance, and site specific soil from the construction project.

1.3 The values stated in SI units are the standard, while the inch-pound units are provided for information. The values expressed in each system may not be exact equivalents; therefore, each system must be used independently of the other, without combining values in any way.

1.4 *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 Textile Materials²

D 653 Terminology Relating to Soil, Rock, and Contained Fluids³

D 4439 Terminology for Geosynthetics³

D 4354 Practice for Sampling of Geosynthetics for Testing³

¹ This test method is under the jurisdiction of ASTM Committee D-35 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.

D 4759 Practice for Determining the Specification Conformance of Geosynthetics³

2.2 *American Public Health Association (APHA) Standard: 208D Total Nonfiltrable Residue Dried at 103–105°C (Total Suspended Matter)*⁴

3. Terminology

3.1 Definitions:

3.1.1 *filtration*—See *filter*.

3.1.2 *filter*—See Terminology D 653.

3.1.3 *geosynthetic, n*—a planar product manufactured from polymeric material used with foundation soil, rock, earth, or any other geotechnical engineering related material as an integral part of a man-made project, structure, or system. (See Practice D 4759.)

3.1.4 *geotextile, n*—any permeable textile material used with foundation, soil, rock, earth, or any other geotechnical engineering related material, as an integral part of a man-made project, structure, or system.

3.1.5 *performance property, n*—a result obtained by conducting a performance test.

3.1.6 *performance test, n*—in *geosynthetics*, a laboratory procedure which simulates selected field conditions which can be used in design.

3.1.7 For definitions of other terms relating to geosynthetics, refer to Terminology D 4439. For definitions of textile terms, refer to Terminology D 123. For definitions of soil terms, refer to Terminology D 653.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *filtering efficiency, FE, n*—in *geosynthetics*, the percent of sediment removed from sediment-laden water by a geotextile over a specified period of time.

3.2.2 *flow rate, FR* [$L^3L^{-2}T^{-1}$], *n*—in *geosynthetics*, the volume of fluid per unit time, expressed as an average, which passes through a cross-sectional plane perpendicular to the fluid flow.

3.2.3 *flume, n*—an apparatus that carries a liquid to an outlet.

3.2.4 *silt fence, n*—in *geosynthetics*, a temporary sediment control measure used to remove soil from runoff.

⁴ Available from American Public Health Association (APHA), 1015 Eighteenth St. NW, Washington, DC 20036.

4. Summary of Test Method

4.1 A geotextile specimen is placed across a flume while sediment-laden water is passed through the specimen.

4.1.1 The time that water flows through the geotextile and the amount of soil passed by the geotextile are measured. The amount of soil retained, filtering efficiency, and flow rate are calculated from these measured values.

4.2 Soil from the construction project should be used in this test method.

5. Significance and Use

5.1 This test method is used to determine the filtering efficiency and flow rate of a geotextile used in a silt fence or silt barrier installation for specific soil conditions.

5.2 This test method may be used for the design of a silt fence or silt barrier to meet requirements of regulatory agencies in filtering efficiency or flow rate for specific soil conditions.

5.2.1 The designer can use this test method to determine the spacing between silt fences or silt barriers.

5.3 This test method is intended for performance evaluation, as the results will depend on the specific soil evaluated. It is

recommended that the user or representative perform the test to pre-approved products, as geotextile manufacturers are not typically equipped to handle or test soil requirements.

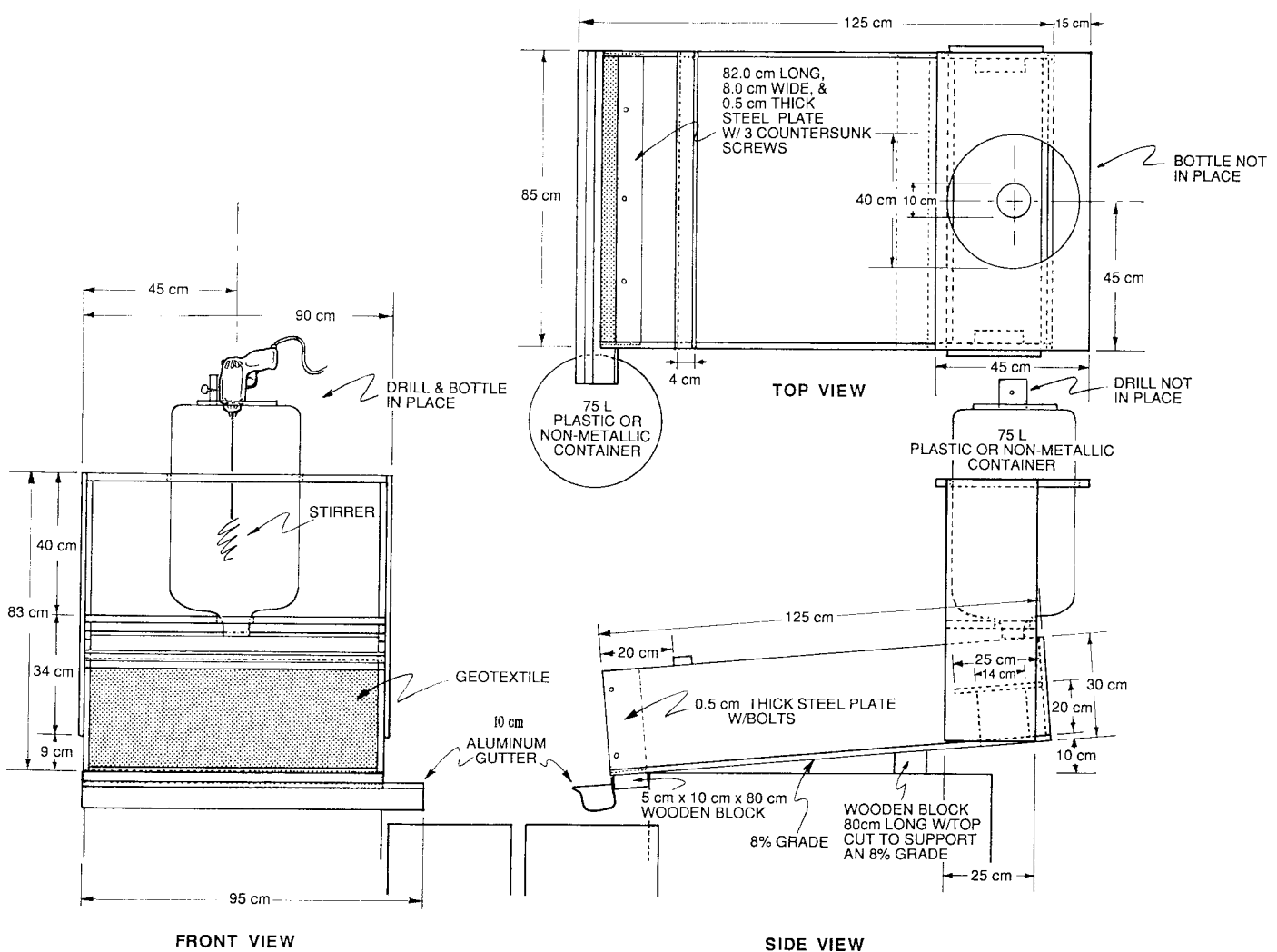
5.4 This test method provides a means of evaluating geotextiles with different soils under various conditions that simulate the conditions that exist in a silt fence or silt barrier installation. This test method may be used to simulate several storm events on the same geotextile specimen. Therefore, the number of times this test is repeated per specimen is dependent upon the user and the site conditions.

6. Apparatus

6.1 *Flume*, constructed from marine-grade plywood, plexi-glas, aluminum, or other material. The flume should be watertight and constructed as shown in Fig. 1.

NOTE 2—Metal flumes should be mounted on a wood frame. The flume opening is the standard length of a straw bale. With a standard length flume of 122 cm (48 in.), the height of the back of the flume would be elevated 10 cm (3⁷/₈ in.).

6.2 *Sample Cutter*, appropriate to prepare test specimens.



NOTE 1—Sides and bottom of flume can be constructed of 2-cm thick marine grade plywood.

FIG. 1 Flume

6.3 *Integrated Water Sampler*,⁵ a 500-mL (0.13-gal) device used to collect integrated samples of water.

6.4 *Two Containers*, 75-L (20-gal), plastic or nonmetallic.

6.5 *Stopwatch*.

6.6 *Stirrer*, such as a stirring rod on a portable electric drill.

6.7 *Sediment-Free Water*, containing no flocculent agents.

NOTE 3—Flocculent agents used in water treatment may cause erroneous results by affecting the settling rate of soil particles in the water.

6.8 *Soil*, site-specific.

6.9 *Gooch Crucible*.

6.10 *Membrane Filter Apparatus*.

6.11 *Vacuum Pump*.

6.12 *Planchet*, aluminum or stainless steel.

6.13 *Desiccator*.

6.14 *Analytical Balance*, sensitivity of 0.00001 g.

7. Sampling

7.1 *Geotextile*:

7.1.1 *Lot Sample*—Divide the product into lots and take the lot sample as directed in Practice D 4354.

7.1.2 *Laboratory Sample*—After first discarding a minimum of 1 m (3.3 ft) of geotextile from the end of the roll, cut off sufficient length of the roll to get the appropriate number of test specimens. If holes or damaged areas are evident, then damaged material should be discarded and additional material sampled.

7.1.3 *Test Specimens*—Cut the appropriate number of specimens to be tested from the machine direction of the laboratory sample by a random method. Each test specimen should be cut (1 m long by 0.3 m wide (3.3 ft long by 12 in. wide)) to fit the flume.

NOTE 4—No specimen should be within 0.2 m (6 in.) of a selvage.

7.2 *Soil*—Obtain representative samples of the site-specific soil that is significant to the design of the silt barriers or silt fences on the construction project. The size and type of sample required is dependent upon the number of tests to be performed and the percent of coarse particles in the sample.

8. Procedure

8.1 Place the geotextile tautly across the flume opening and fasten securely in place to ensure that the test specimen has no wrinkles or loose sections.

8.2 Elevate the back of the flume to an 8 % slope. (See Fig. 1.)

8.3 Pre-wet the geotextile by running one test with 50 L (13.3 gal) of sediment-free water. Record the temperature of the water.

8.4 Mix 0.15 kg (0.33 lb) of air-dried site-specific soil in 50 L (13.3 gal) of untreated water placed in a 75-L (20-gal) container. These soil particles are smaller than 2 mm, the opening size of a No. 10 sieve. Thoroughly agitate the solution with a stirrer for 1 min to obtain a uniform mix.

8.5 While continuing to mix the solution, release the sediment-laden water at the upper end of the flume. Release of

the solution should take less than 10 s. Start the timer at release.

8.6 Rinse the mixing container with no more than 2 L (0.5 gal) of additional water and release into the flume.

8.7 Time the flow of water through the geotextile until no water remains behind the geotextile or 25 min has elapsed. If 25 min have elapsed and water remains behind the geotextile, then measure the distance from the geotextile to the edge of the water behind the geotextile.

8.8 Collect all filtrate caught by the gutter in a second container, until no water remains behind the geotextile or 25 min has elapsed.

8.9 At the completion of the test, agitate the collected filtrate with a stirrer until the mixture is uniformly mixed. After 1 min of mixing, obtain a depth-integrated suspended-solids sample from the mixture while continuing the agitation.

NOTE 5—With the sampler specified in 6.3, a rate of sampling that requires 30 s to reach the bottom of the container and 30 s to return to the surface is ideal. This sampling procedure allows collection of a sample over the full depth of the mixture.

8.10 Place a glass fiber filter disk either on a membrane filter apparatus or in the bottom of a suitable Gooch crucible. Apply a vacuum and wash the disk with three successive 20-mL portions of distilled water. Continue suction to remove all traces of water from the disk.

8.11 Carefully remove the filter disk from the membrane filter apparatus and transfer to an aluminum or stainless steel planchet. If a Gooch crucible is used, remove the crucible and filter disk combination.

8.12 Dry the filter disk for at least 1 h in an oven at 103 to 105°C.

8.13 Store in a desiccator until cooled to room temperature.

8.14 Weigh the filter disk to an accuracy of 0.00001 g.

8.15 Place the filter disk in the membrane filter apparatus and return it or the Gooch crucible to the vacuuming and filtering apparatus.

8.16 Under the vacuum, filter the sample of water collected in 8.9.

8.17 Repeat 8.11-8.14.

9. Calculation

9.1 Calculate suspended solids, as follows:

$$S_s = \frac{(A - B) \times 1000}{C} \quad (1)$$

where:

S_s = suspended solids, ppm,

A = weight of filter plus residue, and

B = weight of filter, and

C = sample, mL.

9.2 Calculate the percent filtering efficiency (F_E) for the geotextile specimen, as follows:

$$F_E = \frac{2890 - S_s}{2890} \times 100 \quad (2)$$

where:

S_s = suspended solids after filtration, ppm, (Eq 1), and

2890 = sediment placed behind the geotextile, ppm.

9.3 Calculate the flow rate (F_T) of the geotextile specimen

⁵ The US DH-48 integrated water sampler has been found to be satisfactory. It is available from the Federal Inter-Agency Sedimentation Project, St. Anthony Falls Hydraulic Laboratory, 3rd Avenue S.E., Minneapolis, MN 55414.

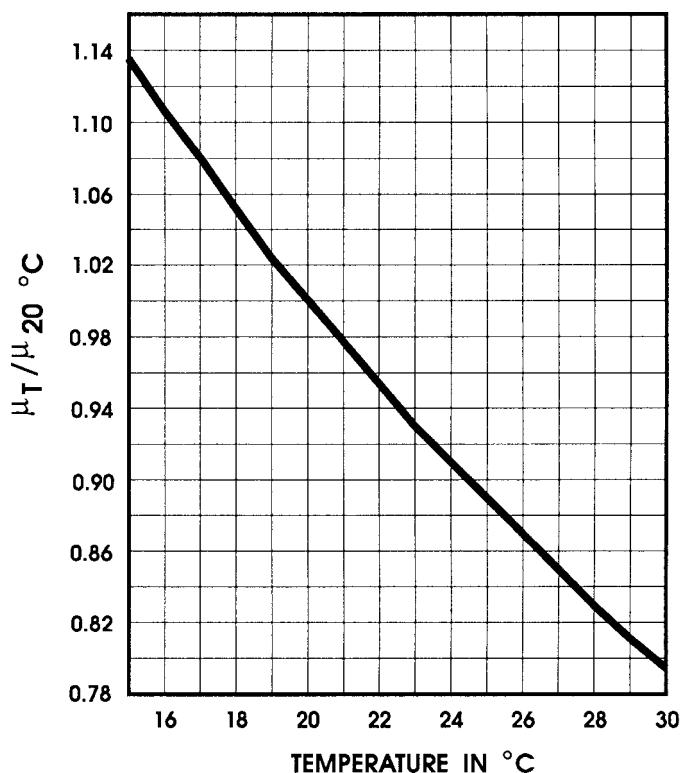


FIG. 2 The Ratio of Viscosity of Water at Temp, T, to the Viscosity of Water at 20°C

using Eq 3 (complete drainage) or Eq 4 (25 min elapsed time):

$$F_T \text{ (m}^3\text{/m}^2\text{/min)} = 0.6589/t \tag{3}$$

or

$$F_T \text{ (m}^3\text{/m}^2\text{/min)} = \frac{14.0575 - 0.006x^2}{0.8533 - 0.01778x} t \tag{4}$$

where:

- T = temperature of the water,
- t = time measured in 8.7, min, and
- x = distance from the geotextile to the edge of the water behind the geotextile in mm (see 8.7).

9.3.1 Correct the flow rate to 20°C using Eq 5:

$$F_{20^\circ C} = \frac{F_T U_T}{U_{20^\circ C}} \tag{5}$$

where:

$$\frac{U_T}{U_{20^\circ C}} = \text{ratio of viscosity of water at temperature T to viscosity of water at } 20^\circ\text{C (see Fig. 2).}$$

10. Report

10.1 The report of filtering efficiency and flow rate should include the following information:

10.1.1 State that the specimens were tested as directed in this test method, and describe the type of geotextile tested and the sampling method used,

10.1.2 The number of specimens tested and the direction(s) tested (if applicable),

10.1.3 The type of soil used and any data showing pertinent physical properties of the soil, such as gradation curve, Atterberg limits, etc.,

10.1.4 Complete test data including temperature of the water, recorded flow rates, length of test (25 min or elapsed time), suspended solids contents, and filtering efficiencies for each trial, and

10.1.5 A statement of any deviation from the described test method.

11. Precision and Bias

11.1 *Precision*—The precision of the procedure in this test method for measuring filtering efficiency and flow rate of a geotextile is being established.

11.2 *Bias*—The procedure in this test method for measuring filtering efficiency and flow rate of a geotextile has no bias because the values of those properties can be defined only in terms of a test method.

12. Keywords

12.1 filtering efficiency; flow rate; silt barrier; silt fence

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