



Designation: D5887/D5887M – 23

Standard Test Method for Measurement of Index Flux Through Saturated Geosynthetic Clay Liner Specimens Using a Flexible Wall Permeameter¹

This standard is issued under the fixed designation D5887/D5887M; 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 an index test that covers laboratory measurement of flux through saturated geosynthetic clay liner (GCL) specimens using a flexible wall permeameter.

1.2 This test method is applicable to GCL products having geotextile backing(s). It is not applicable to GCL products with geomembrane backing(s), geofilm backing(s), or polymer coating backing(s).

1.3 This test method provides a measurement of flux under a prescribed set of conditions that can be used for manufacturing quality control. The test method can also be used to check conformance. The flux value determined using this test method is not considered to be representative of the in-service flux of GCLs.

1.4 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system are not necessarily exact equivalents; therefore, to ensure conformance with the standard, each system shall be used independently of the other, and values from the two systems shall not be combined.

1.5 *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.*

1.6 *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.*

¹ This test method is under the jurisdiction of ASTM Committee D35 on Geosynthetics and is the direct responsibility of Subcommittee D35.04 on Geosynthetic Clay Liners.

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2. Referenced Documents

2.1 *ASTM Standards:*²

D374/D374M Test Methods for Thickness of Solid Electrical Insulation

D653 Terminology Relating to Soil, Rock, and Contained Fluids

D2216 Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass

D4439 Terminology for Geosynthetics

D4753 Guide for Evaluating, Selecting, and Specifying Balances and Standard Masses for Use in Soil, Rock, and Construction Materials Testing

E145 Specification for Gravity-Convection and Forced-Ventilation Ovens

E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

3. Terminology

3.1 *Definitions:*

3.1.1 *flux, n*—the rate of discharge of water under laminar flow conditions through a unit cross-sectional area of a GCL specimen.

3.1.2 *geosynthetic clay liner (GCL), n*—a factory-manufactured geosynthetic hydraulic barrier consisting of clay supported by geotextiles or geomembranes, or both, that are held together by needling, stitching, or chemical adhesives.

3.1.3 *index test, n*—a test procedure that may contain a bias, but that may be used to establish an order for a set of specimens with respect to the property of interest.

3.1.4 For definitions of other terms used in this test method, see Terminologies D653 and D4439.

4. Summary of Test Method

4.1 This test method involves permeation of a 100 mm [4 in.] diameter GCL test specimen. The specimen is set up in

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.

a flexible wall permeameter and subjected to a total stress of 550 kPa [80 psi] and a back pressure of 515 kPa [75 psi] for a period of 48 h. Flow is initiated using deionized water by raising the pressure on the influent side of the test specimen to 530 kPa [77 psi]. The flux is determined when inflow and outflow are approximately equal (within $\pm 25\%$).

5. Significance and Use

5.1 This test method yields the flux of water through a saturated GCL specimen that is consolidated, hydrated, and permeated under a prescribed set of conditions.

5.2 This test method can be performed to determine if the flux of a GCL specimen exceeds the maximum value stated by the manufacturer.

5.3 This test method can be used to determine the variation in flux within a sample of GCL by testing a number of different specimens.

5.4 This test method does not provide a flux value to be used directly in design calculations.

NOTE 1—Flux for in-service conditions depends on a number of factors, including confining pressure, type of hydration fluid, degree of hydration, degree of saturation, type of permeating fluid, and hydraulic gradient. Correlation between flux values obtained with this test method and flux through GCLs subjected to in-service conditions has not been fully investigated.

5.5 This test method does not provide a value of hydraulic conductivity. Although hydraulic conductivity can be determined in a manner similar to the method described in this test method, the thickness of the specimen is needed to calculate hydraulic conductivity. This test method does not include procedures for measuring the thickness of the GCL nor of the clay component within the GCL. Refer to [Appendix X2](#) for calculation of hydraulic conductivity.

5.6 The apparatus used in this test method is commonly used to determine the hydraulic conductivity of soil specimens. However, flux values measured in this test are typically much lower than those commonly measured for most natural soils. It is essential that the leakage rate of the apparatus used in this test be less than 10 % of the flux.

6. Apparatus

6.1 *Hydraulic System*, constant head (Test Method A), falling head (Test Methods B and C), or constant rate of flow (Test Method D) systems may be utilized provided they meet the criteria outlined as follows:

6.1.1 *Constant Head*—The system shall be capable of maintaining constant hydraulic pressures to within $\pm 5\%$ and shall include means to measure the hydraulic pressures to within the prescribed tolerance. In addition, the head loss across the test specimen must be held constant to within $\pm 5\%$ and shall be measured with the same accuracy or better. Pressures shall be measured by a pressure gauge, electronic pressure transducer, or any other device of suitable accuracy.

6.1.2 *Falling Head*—The system shall allow for measurement of the applied head loss to within $\pm 5\%$ at any time. In addition, the ratio of initial head loss divided by final head loss over an interval of time shall be measured such that this

computed ratio is accurate to within $\pm 5\%$. The head loss shall be measured with a pressure gauge, electronic pressure transducer, engineer's scale, graduated pipette, or any other device of suitable accuracy. Falling head tests may be performed with either a constant tailwater elevation (Test Method B) or a rising tailwater elevation (Test Method C).

6.1.3 *Constant Rate of Flow*—The system shall be capable of maintaining a constant rate of flow through the specimen to within $\pm 5\%$. Flow measurement shall be by calibrated syringe, graduated pipette, or other device of suitable accuracy. The head loss across the specimens shall be measured to an accuracy of $\pm 5\%$ using an electronic pressure transducer or other device of suitable accuracy. More information on testing with a constant rate of flow is given in the literature.³

6.1.4 *System De-Airing*—The hydraulic system shall be designed to facilitate rapid and complete removal of free air bubbles from flow lines.

6.1.5 *Back Pressure System*—The hydraulic system shall have the capability to apply back pressure to the specimen to facilitate saturation. The system shall be capable of maintaining the applied back pressure throughout the duration of hydraulic conductivity measurements. The back pressure system shall be capable of applying, controlling, and measuring the back pressure within $\pm 5\%$ of the applied pressure. The back pressure may be provided by a compressed gas supply, a deadweight acting on a piston, or any other method capable of applying and controlling the back pressure to the tolerance prescribed in this paragraph.

NOTE 2—Application of gas pressure directly to a fluid will dissolve gas in the fluid. A variety of techniques are available to minimize dissolution of gas in the back pressure fluid, including separation of gas and liquid phases with a bladder and frequent replacement of the liquid with de-aired water.

6.2 *Flow Measurement System*—Both inflow and outflow volumes shall be measured unless the lack of leakage, continuity of flow, and cessation of consolidation or swelling can be verified by other means. Flow volumes shall be measured by a graduated accumulator, graduated pipette, vertical standpipe in conjunction with an electronic pressure transducer, or other volume measuring device of suitable accuracy.

6.2.1 *Flow Accuracy*—Required accuracy for the quantity of flow measured over an interval of time is $\pm 5\%$.

6.2.2 *De-Airing and Compliance of the System*—The flow measurement system shall contain a minimum of dead space and be capable of complete and rapid de-airing. Compliance of the system in response to changes in pressure shall be minimized by using a stiff flow measurement system. Rigid tubing, such as metallic or rigid thermoplastic tubing, shall be used.

6.2.3 *Head Losses*—Head losses in the tubes, valves, porous end pieces, and filter paper may lead to error. To guard against such errors, the permeameter shall be assembled with no specimen inside and then the hydraulic system filled. If a constant or falling head test is to be used, the hydraulic

³ Olson, H. W., Morin, R. H., and Nichols, R. W., "Flow Pump Applications in Triaxial Testing," *Symposium on Advanced Triaxial Testing of Soil and Rock*, ASTM STP 977, ASTM International, 1988, pp. 68–81.