Designation: D 5199 – 01

Standard Test Method for Measuring the Nominal Thickness of Geosynthetics[1]

This standard is issued under the fixed designation D 5199; 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 is limited to measuring the nominal thickness of geotextiles, smooth surfaced geomembranes, geonets, and geocomposite drainage products.

1.2 The values stated in SI units are to be regarded as the standard. The values are provided in inch-pound units for information only.

1.3 This test method does not provide thickness values for geosynthetics under variable normal compressive stresses. This test method determines nominal thickness, not necessarily minimum thickness.

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 Textiles[2]

D 1776 Practice for Conditioning Textiles for Testing[2]

D 1777 Method for Measuring Thickness of Textiles Materials[2]

D 4354 Practice for Sampling of Geosynthetics for Testing[3]

D 4439 Terminology for Geosynthetics[3]

3. Terminology

3.1 *Definitions:*

3.1.1 *geomembrane, n*—an essentially impermeable membrane 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.

3.1.2 *geotextiles, n*—a planar product manufactured from polymeric material used with soil, rock, earth, or other geotechnical engineering related material as an integral part of a man-made project, structure, or system.

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

3.1.4 *pressure, n*—the force or load per unit area.

3.1.5 *thickness*—(1) the distance between one planar surface and its opposite parallel and planar surface; (2) in the textiles the distance between the upper and lower surfaces of the material, measured under a specified pressure and time.

3.1.6 For definition of other textile terms used in this standard, refer to Terminology D 123.

3.1.7 For definitions of other terms relating to geotextiles and geomembranes used in this standard, refer to Terminology D 4439.

4. Summary of Test Method

4.1 The nominal thicknesses of geosynthetics is determined by observing the perpendicular distance that a movable plane is displaced from a parallel surface by the geotextile or geomembrane material while under a specified pressure (2 kPa for geotextiles and 20 kPa for geomembranes for 5 s).

5. Significance and Use

5.1 Thickness is one of the basic physical properties used to control the quality of many geosynthetics. Thickness values are required in calculation of some geotextile and geomembrane parameters such as permeability coefficients, tensile stress (index), and the like thickness is not indicative of field performance and therefore is not recommended for specifications.

5.2 The thickness of geotextiles and geomembranes may vary considerably depending on the pressure applied to the specimen during measurement. Where observed changes occur, thickness decreases when applied pressure is increased. To minimize variation, specific sample size and applied pressure are indicated in this method to ensure all results are comparable.

5.3 To determine the effect of difference pressure loadings on the measure thickness of geotextiles and geomembranes, use this test method.

5.4 This test method may be used for acceptance testing of commercial shipments of geotextiles and geomembranes, but caution is advised since information on between-laboratory precision is incomplete. Comparative tests, as directed in 5.4.1 may be advisable.

5.4.1 In case of a dispute arising from differences in reported test results when using this test method for acceptance testing of commercial shipments, the purchaser and the supplier should conduct comparative tests to determine if there is

[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 04.09.

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a statistical bias between their laboratories. Competent statistical assistance is recommended for the investigation of bias. As a minimum, the two parties should take a group of test specimens that are as homogeneous as possible and that are formed from a lot of material of the type in question. The test specimens should be randomly assigned in equal numbers to each laboratory for testing. The average results from the two laboratories should be compared using Student's *t*-test for unpaired data and an acceptable probability level chosen by the two parties before the testing is begun. If bias is found, either its cause must be found and corrected or the purchaser and supplier must agree to interpret future tests in the light of the known bias.

NOTE 1—The user should be aware that the compressibility of the materials, their rebound characteristics, and the like will also affect the thickness of the geotextiles and geomembranes following the time when they are rolled up on rolls shipped and stored.

6. Apparatus

6.1 *Thickness Testing Instrument* —The thickness gage shall have a base (or anvil) and a free moving presser foot plate whose planar faces are parallel to each other to <0.01 mm. A gage with a 56.4 mm (2.22 in.) diameter presser foot, the base shall extend at least 10 mm in all directions further than the edge of the 2500 mm^2 circular pressor foot, shall be used for measurements of geotextiles, geocomposite drainage materials, and geonets. A gage with a 6.35 mm (0.250 in.) diameter pressor foot shall be used for laboratory measurements of geomembranes. A gage with 6.35 mm (0.250 in.) diameter pressor foot and base may be used for field measurements of geomembrane thickness. The instruments must be capable of measuring a maximum thickness of at least 10 mm to an accuracy of at least ±0.02 mm. The gages shall be constructed to permit gradual application of pressure to a specific force of 2 ± 0.02 kPa (0.29 ± 0.003 psi) for geotextiles and 20 ± 0.2 kPa (2.9 ± 0.03 psi) for geomembranes. Dead-weight loading may be used.

6.1.1 The specified force of 20 kPa may be inadequate for some HDPE geomembranes. A pressure in the range of 50 to 200 kPa is recommended for HDPE geomembranes if fictitiously high readings are suspected using the 20 kPa pressure.

NOTE 2—(Appendix X1) lists some of the suppliers of apparatus for thickness measurement.

6.2 *Cutting Dies*— Dies to cut specimens should have dimensions at least as large as a circle of 75 mm (3 in.) diameter.

NOTE 3—Due to compressibility of many geotextiles and geomembranes the cutting and handling preparation may change the thickness. Care should be exercised to minimize these effects.

7. Sampling

7.1 *Lot Sample*—In the absence of other guidelines divide the product into lots and take lot samples as specified in Practice D 4354.

7.2 *Laboratory Sample*—Consider the units in the lot sample as the units in the laboratory sample. For the laboratory sample, take a full width sample of sufficient length along the selvage or edge of the roll so that the requirements of 7.3-7.5.2 can be met. Exclude the inner and outer wraps of the roll or any material containing folds, crushed areas or other distortions not representative of the sampled lot.

7.3 Remove test specimens from the laboratory sample in a randomly distributed pattern across the width with no specimen taken nearer than 100 mm (4 in.) from the selvage or roll edge, unless otherwise specified. For geomembranes include at least one specimen taken no more than 152 mm (6 in.) from the edge. Since seams are an important part of geomembrane applications, thickness readings within 152 mm (6 in.) of each edge is appropriate.

7.4 *Test Specimens*— From each unit in the laboratory sample, remove the specimens so that the edge of the specimen will extend beyond the edge of the pressor foot by 10 mm (0.39 in.) in all directions (that is at least a circle of 75 mm ((3 in.)), diameter).

7.5 *Number of Specimens*—Unless otherwise agreed upon, as when provided in an applicable material specifications, take a number of test specimens per laboratory sample such that the user may expect at the 95 % probability level that the test result is not more than 6.0 % of the average above or below the true average of the sample. Determine the number of specimens per sample as follows:

7.5.1 *Reliable Estimate of v*—When there is a reliable estimate of *v* based upon extensive part records for similar materials tested in the user's laboratory as directed in the method, calculate the required number of specimens for the machine and cross-machine directions as follows:

$$n = (tv / A)^2$$

where:

- n = number of test specimens (rounded upward to a whole number),
- v = reliable estimate of the coefficient of variation of individual observations on similar materials in the user's laboratory under conditions of single-operation precision, %,
- t = the value of Student's *t* for one-sided limits (see Table 1), a 95 % probability level, and the degrees of freedom associated with the estimate of *v,* and
- A = 5.0 % of the average, the value of the allowable variation.

7.5.2 *No Reliable Estimate of v*—When there is no reliable estimate of *v* for the user's laboratory, Eq 1 should not be used directly. Instead, specify the fixed number (10) of specimens. The number of specimens is calculated using *v = 9.5 %* of the average. These values for *v* are somewhat larger than usually found in practice. When a reliable estimate of *v* for the user's laboratory becomes available, Eq 1 will usually require fewer than the fixed number of specimens.

8. Conditioning

8.1 Bring the specimens to moisture equilibrium in the atmosphere for testing geotextiles and geomembranes, that is temperature of 21 ± 2°C (70 ± 4°F) and relative humidity of 60 ± 10 %.

8.2 Moisture Equilibrium is considered to have been reached when the increase in mass of the specimen, in successive weighings made at intervals of not less than 2 h,

TABLE 1 Values of Student's *t* for Two-Sided Limits and the 95 % Probability[A]

df	*t*.025	df	*t*.025	df	*t*.025
1	12.706	11	2.201	21	2.080
2	4.303	12	2.179	22	2.074
3	3.182	13	2.160	23	2.069
4	2.776	14	2.145	24	2.064
5	2.571	15	2.131	25	2.060
6	2.447	16	2.120	26	2.056
7	2.365	17	2.110	27	2.052
8	2.306	18	2.101	28	2.048
9	2.262	19	2.093	29	2.045
10	2.228	20	2.086	inf.	1.960

[A] Values in this table were calculated using Hewlett Packard HP 67/97 Users' Library Programs 03848D, "One-Sided and Two-Sided Critical Values of Student's *t*" and 00350D, "Improved Normal and Inverse Distribution." For values at other than the 95 % probability level, see published tables of critical values of Student's *t* in any standard statistical text. Further use of this table is defined in Practice D 2905.

does not exceed 0.1 % of the mass of the specimen. In general, many geotextiles and geomembranes contain more moisture when received than they will after reaching moisture equilibrium.

NOTE 4—It is recognized that in practice, geotextiles and geomembranes are frequently not weighed to determine when moisture equilibrium has been reached. While such a method cannot be accepted in cases of dispute, it may be sufficient in routine testing for a reasonable period of time before the specimens are tested. A time of at least 24 h has been found acceptable in most cases. However, fibers may contain more moisture upon receipt than after conditioning and lose moisture relatively slowly during conditioning. When this is known, a preconditioning cycle, as described in Practice D 1776, may be agreed upon by the contractual parties for routine testing.

9. Procedure

9.1 Test the conditioned specimens in the standard atmosphere specified in 8.1.

9.2 Handle the test specimens carefully to avoid altering the natural state of the material.

9.3 *Procedure A - Geotextiles, Geocomposite Drainage Materials, and Geonets:* With the force applied to the pressor foot on the base (no test specimen present), zero the measuring scale or record the "base reading." Lift the presser foot, center the test specimen on the base under the presser foot, and bring the presser foot into contact with the material. Gradually increase the pressure to 2 kPa (0.29 psi). After the full force has been applied to presser foot for 5 s against the specimen, record the thickness value to the nearest 0.02 mm and remove the specimen from the test device.

9.4 *Procedure B - Smooth Surfaced Geomembranes:* With the force applied to the pressor foot on the base (no test specimen present), zero the measuring scale or record the "base reading." Lift the presser foot, center the specimen on the base under the presser foot, and bring the presser foot into contact with the material. Gradually increase the pressure to 20 kPa (2.9 psi). After the full force has been applied to presser foot for 5 s against the specimen, record the thickness value to the nearest 0.02 mm and remove the specimen from the test device.

10. Calculation

10.1 Calculate the average of the thickness for all test results as read directly from the test instrument.

11. Report

11.1 The report for the nominal thickness shall include the following information:

11.1.1 Project, type of geotextile or geomembranes tested, and method of sampling.

11.1.2 Name or description of thickness apparatus used for testing.

11.1.3 Dimensions of the presser foot and of the specimen.

11.1.4 Loading time interval.

11.1.5 Number of tests.

11.1.6 Average nominal thickness, and

11.1.7 Coefficient of variation of thickness in the sample, in percent (optional).

11.1.8 Any unusual or out of standard conditions or observations made during the tests.

12. Precision and Bias

12.1 *Precision: Geotextiles*:

12.1.1 *Inter-Laboratory Test Program*[4]— An inter-laboratory study of Test Method D 5199 was performed in 1994. Each of six laboratories tested ten randomly drawn specimens from each of four materials.

12.1.2 *Result*—The precision information given below has been calculated for the comparison of six test results, each of which is the average of ten specimens. Four different materials were tested.

12.1.3 *95 % Repeatability Limit* —The repeatability limit is 14 % of the test results. For the different materials, the repeatability limits range from 22 % to 9 %.

12.1.4 *95 % Reproducibility Limit (Between Laboratory)*— The reproducibility limit is 23 % of the test results. For the different materials, the repeatability limits range from 33 % to 17 %.

12.1.5 The respective coefficients of variation percentages for the test results may be obtained by dividing the above numbers by 2.8. Hence for the four materials tested:

Repeatability	Reproducibility
Material A—8 %	Material A—12 %
Material B—4 %	Material B— 8 %
Material C—3 %	Material C— 7 %
Material D—5 %	Material D— 6 %

12.2 *Precision: Smooth Surfaced Geomembranes*

12.2.1 *Inter-Laboratory Test Program*[4]— An inter-laboratory study of Test Method D 5199 was performed in 1994. Each of three laboratories tested ten randomly drawn specimens from each of four materials.

12.2.2 *Result*—The precision information given below has been calculated for the comparison of three test results, each of which is the average of ten specimens. Four different materials were tested.

12.2.3 *95 % Repeatability Limit* —The repeatability limit is 5 % of the test results. For the different materials, the repeatability limits range from 8 % to 2 %.

12.2.4 *95 % Reproducibility Limit (Between Laboratory)*— The reproducibility limit is 12 % of the test results. For the

[4] The design of the experiment, similar to that of Practice E 691, and a within-between analyzer of the data will be available.

different materials, the repeatability limits range from 18 % to 8 %.

12.2.5 The respective coefficients of variation percentages for the test results may be obtained by dividing the above numbers by 2.8. Hence for the four materials tested:

Repeatability	Reproducibility
Material A—1 %	Material A—4 %
Material B—1 %	Material B—7 %
Material C—3 %	Material C—3 %
Material D—2 %	Material D—4 %

12.3 *Precision*:

Geonet and Geocomposite

12.3.1 *Inter-Laboratory Test Program*—An inter-laboratory study of Test Method D5199 was performed in 1999. Three sets (ten test specimens each) which were randomly drawn from each material, one geonet and one double-sided geocomposite, that were tested for thickness in each of the five laboratories. The design of the experiment, similar to that of Practice E691, and a within-between analysis of the data are given in an ASTM Research Report.[5]

12.3.2 *Test Result*—The precision information is given below. The precision values are for the thickness test results and are in terms of coefficients of variation, CV%.

12.3.3 *Precision*:

Statistic	Geonet	Geocomposite
Average thickness, mm	5.64	6.98
Within-laboratory repeatability limit, CV%r	1.6 %	1.0 %
Between-laboratory reproducibility limit, CV%R	3.9 %	1.6 %
95 % confidence limit, within-laboratory repeatability, 2.8 CV%r	4.4 %	3.0 %
95 % confidence limit, within-laboratory reproducibility, 2.8 CV%R	10.8 %	4.3 %

12.4 *Bias*—The procedure in this test method has no bias because the value of that property can only be defined in terms of the test method.

13. Keywords

13.1 sample; selvage; specimen

[5] Supporting data have been filed at ASTM Headquarters. Request RR:D35–1009.

APPENDIX

(Nonmandatory Information)

X1. Suppliers

X1.1 Some Suppliers of Thickness Measuring Apparatus—American Instrument Company, Custom Scientific Instruments, Ind., Federal Products Corporation, Frank E. Randall Company, Inc., Frazier Precision Instrument Company, Inc., Testing Machines, Inc., The Ames Company, and Thwing-Albert Instrument Company.

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