Designation: D6364 – 06 (Reapproved 2011)

Standard Test Method for Determining Short-Term Compression Behavior of Geosynthetics[1]

This standard is issued under the fixed designation D6364; 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 the procedures for evaluation of the deformations of a geosynthetic or combination of geosynthetics (that is, geocomposite (excluding geotextiles, geomembranes, and geosynthetic clay liners)) under short-term compressive loading. This test method is strictly an index test method to be used to verify the compressive strength consistency of a given manufactured geosynthetic(s). Results from this test method should not be considered as an indication of actual or long-term performance of the geosynthetic(s) in field applications.

1.2 Since these geosynthetics may experience muti-directional compressive loadings in the field, this test method will not show actual field performance and should not be used for this specific objective. The evaluator of the results should also recognize that the determination of the short-term single plane compressive behavior of geosynthetics does not reflect the installed performance of synthetic drainage systems and, therefore, should not be used as the only method of product specification or performance with respect to synthetic drainage systems.

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

1.4 The values in SI units are to be regarded as the standard. Values in inch-pound units are provided in parentheses for information.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D4354 Practice for Sampling of Geosynthetics and Rolled Erosion Control Products(RECPs) for Testing
D4439 Terminology for Geosynthetics
D5199 Test Method for Measuring the Nominal Thickness of Geosynthetics
D7001 Specification for Geocomposites for Pavement Edge Drains and Other High-Flow Applications

3. Terminology

3.1 *Definitions:*

3.1.1 *compressive deformation, [L], n*—the decrease in gage length produced in the test specimen by a compressive load.

3.1.2 *compressive strain, [nd], n*—the ratio of compressive deformation to the gage length of the test specimen.

3.1.3 *gage length, [L], n—in compression testing,* the measured thickness of the test specimen under specified compressional force, expressed in units of length prior to compressive loading. **(D5199)**

3.1.4 *geocomposite, n*—a product fabricated from any combination of geosynthetics with geotechnical materials or other synthetics that is used in a geotechnical application.

3.1.5 *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. **(D4439)**

3.1.6 *index test, n*—a test procedure that may contain a known bias but that may be used to establish an order for a set of specimens with respect to the property of interest. **(D4439)**

3.1.7 *yield point, n*—the first point on the load-deformation curve at which an increase in deformation occurs without a corresponding increase in load.

3.1.7.1 *Discussion*—Some geosynthetics do not exhibit an exact yield point. The tested geosynthetic may exhibit a less steep slope at yield. In addition, it should be stated that the yield point may also be the ultimate strength of the geosynthetic.

3.1.8 For definitions of terms relating to geotextiles, refer to Terminology D4439

[1] This test method is under the jurisdiction of ASTM Committee D35 on Geosynthetics and is the direct responsibility of Subcommittee D35.01 on Mechanical Properties.

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[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.

4. Summary of Test Method

4.1 Specimens are mounted between parallel plates in a load frame. Compressive loads are applied at a constant rate of crosshead movement. The deformations are recorded as a function of load. The compressive stress and strain are evaluated and plotted. The compressive yield point is evaluated from the stress/strain relationship for those materials that exhibit a detectable compressive yield point.

5. Significance and Use

5.1 The compression behavior test for geosynthetics is intended to be an index test. It is anticipated that the results of the compression behavior test will be used to evaluate product. The results of the analyses may also be used to compare the relative compressive yield points of materials that exhibit a detectable compressive yield point. It is anticipated that this test will be used for quality control testing to evaluate uniformity and consistency within a lot or between lots where sample geometry factors (for example, thickness) or materials may have changed.

NOTE 1—This is a one-dimensional test for compressive loading of a geosynthetic(s) in one plane.

5.1.1 The compressive yield point of geosynthetics may be evaluated from the stress/strain relationship. Many materials exhibit compressive deformation but may not show a distinct compressive yield point.

5.2 This test method can be used to evaluate the short-term stress/strain behavior of geosynthetics under compressive stress while loaded at a constant rate of deformation.

5.3 This test method may be used for acceptance testing of commercial shipments of geosynthetics but caution is advised because interlab testing is incomplete.

5.3.1 In the 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 statistical bias between their laboratories. Competent statistical assistance is recommended for the investigation of bias. As a minimum, two parties should take a group of test specimens from material shipped to the project. The test specimens should then be randomly assigned in equal numbers to each laboratory for testing. The average results from the two laboratories should be compared using the 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 test results in the light of the known bias.

6. Apparatus

6.1 *Loading Mechanism*—The loading mechanism shall be capable of applying compressive loads at a constant rate of deformation of 10 % on the nominal thickness of the test specimen per minute or 1 mm/min, whichever is greater. The capacity of the load frame shall be at least two times greater than the compressive yield point of or the maximum load applied to the specimen.

NOTE 2—Some loading mechanisms, especially the older models, do not have the capability of adjusting the rate of deformation to the specific rate required. For these instruments, the user and producer should establish mutually agreed upon testing rates. However, the rate of deformation selected should not be greater than 10 % on the nominal thickness of the test specimen per minute or 1 mm/min, whichever is greater.

6.2 *Fixed Plate*—The fixed plate shall be larger than the specimen to be tested. It shall also be flat, smooth, and completely and uniformly supported.

NOTE 3—It is recommended that the minimum fixed plate width be equal to the sample width plus twice the thickness of the test sample. This should support the sample through the range of deformation and prevent draping or flexing displacement.

6.3 *Movable Plate*—The movable plate shall be of sufficient thickness and strength to preclude any bending during loading. It shall be parallel to the fixed plate and attached to the compression mechanism. A spherical loading block of the suspended, self-aligning type is recommended. The dimensions and shape of the movable plate shall depend on the specimen dimensions and geometry. In general, both length and width of the movable plate should each be at least 20 % greater than the length and width of the specimens.

NOTE 4—Where the sample exhibits excessive surface irregularities or variation in thickness, the plates may be modified to accommodate surface irregularities and thickness variations. This can be achieved by the insertion of a layer of hardening paste between the specimen and the plates. The surface of the specimen may require covering with a flexible film to inhibit the intrusion of the paste into the specimen. The hardened paste, when fully cured, must be well adhered to the loading plates and have compressive and shear strength properties at least a magnitude greater than the specimen to be tested.

6.4 *Variable Plates (Required for High-Flow Products per Specification D7001)*— Variable inclined plates or set angled blocks should be used to test the specimen under non-axial conditions. The test apparatus shall have one fixed plate and one movable plate. Fig. 1 shows set angled blocks with a movable base block with a roller system to allow lateral movement of the block during deformation (see 6.4.1). The base and top inclined plates can be adjustable angle plates. The inclined plates or set angled blocks must meet the requirements as stated in 6.3 of this test method. The base and top inclined plates or blocks must have a matched set of angles that differ by no more than 0.5 degrees. The incline plates or blocks shall be roughened or ribbed to keep specimen from sliding down the fixed plate or block during the test. The samples should be marked in regards to plates or blocks to check for slippage during the test. If mutual agreement is obtained between the manufacturer and user, other facings to the plates or blocks can be used. Allowable percent reduction in strength based on the load angle should also be agreed upon.

NOTE 5—The use of inclined plates or blocks may assist the manufacturer or user to evaluate the deformation of the geosynthetic(s) under loading at various angles. The use of inclined plates may not reflect the in-service performance of synthetic drainage systems.

6.4.1 **Warning**—The deformation of the geosynthetics within a testing apparatus may occur rapidly in a lateral direction (or not in the direction of loading) which could damage the testing apparatus. This is particularly true when the geosynthetic is tested using inclined plates. The user of this test

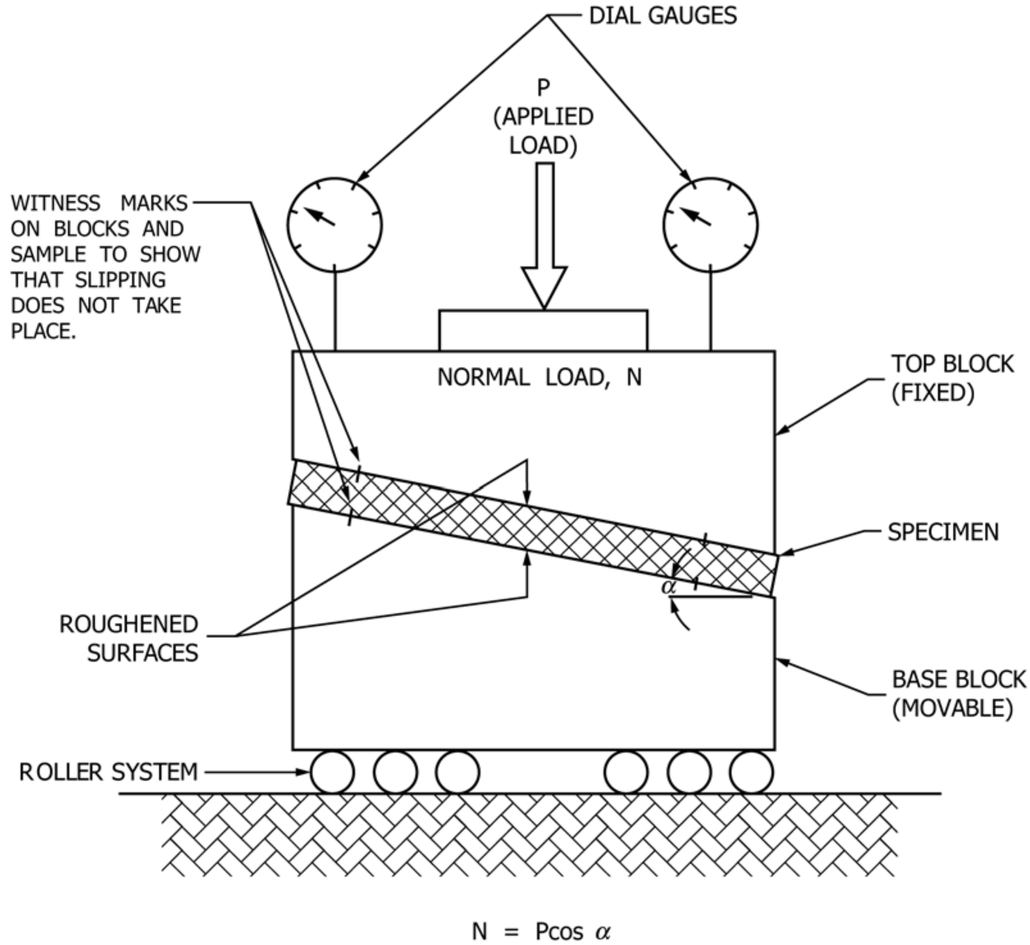

FIG. 1 Example of Inclined Blocks

method must be aware the testing apparatus' ability to handle a lateral movement of the geosynthetic or loading plate during the performance of this test.

6.5 *Load Indicator*—Use a load-indicating mechanism that has an accuracy of ±1 % of the maximum indicated value of the test (force).

6.6 *Deformation Indicator*—Use a deformation-indicating mechanism that has an accuracy of ±1.0 % of the maximum indicated value of the test (deformation).

6.7 *Micrometer Dial Gage,* caliper or steel rule, suitable for measuring dimensions of the specimens to ±1 %.

7. Sampling

7.1 *Lot Sample*—Divide the product into lots and take the lot sample as directed in Practice D4354, only if it pertains to geosynthetics listed in Practice D4354.

7.2 *Laboratory Sample*—Units in the laboratory sample should be the same as the units in the lot sample for the lot to be tested. Take a sample extending across the full width (that is, cross-machine direction) of the geosynthetic production unit of sufficient length (that is, machine direction) so that the requirements of 7.3 can be met. Take a sample that will exclude material from the outer wrap of a roll (if applicable) unless the sample is taken at the production site, then the inner and outer wrap material may be used. Geocomposites, which have unbonded distinct materials (for example, sock wrapped geosynthetic drain), should be sampled as a complete unit and maintained as a complete unit through the testing process.

7.3 *Test Specimens*—Cut five specimens from each unit in the laboratory sample with each specimen being at least 120 mm × 120 mm (4.7 in. × 4.7 in.) square. For geosynthetics that have a repeating pattern of discrete support points (columns, cusps, nodes, etc.) that are symmetrical about orthogonal axes, rectangular or square specimens are recommended. The minimum specimen length and width shall include at least five complete support points along each major axis of the geosynthetic or be 120 mm (4.7 in.), whichever is greater. When testing geosynthetics that have repeating patterns that are not orthogonal to the length and width of the geosynthetic, use a specimen size agreed upon by the purchaser and the supplier. When the design of the geosynthetic is such that cutting in the width direction would change its structural integrity, the full width of the geosynthetic should be tested.

8. Conditioning

8.1 Test the specimens in a laboratory with air maintained at a temperature of 21 ± 2°C (70 ± 4°F) and a relative humidity between 50 % – 70 %.

8.2 If the user determines that the geosynthetic is to be tested in the wet condition, saturate the specimen in water at the temperature described in 8.1 for a minimum of 24 h prior to testing.

NOTE 6—Geosynthetics, which do not absorb measurable quantities of water, should be saturated for a minimum of 3 h prior to testing.

9. Procedure

9.1 Measure the length, width, and thickness of the specimen to an accuracy of ±1 %. For geosynthetics with a repeating pattern of discrete support points, measure the spacing of the repeating features in order to determine the number of support points per square metre. Also, record the number of complete support points in the specimens.

9.1.1 The nominal thickness shall be determined using Test Method D5199 at 20 kPa (2.9 lbf/in.^{2}), since this is the minimum pressure at which geocomposites remain flat.

9.2 The test specimen shall be placed on the bottom plate and centered with respect to the axis of the loading mechanism. The loading mechanism shall be moving at the required constant speed at or before the point of contact with the sample.

9.3 The rate of crosshead movement shall be 10 % on the nominal thickness of the test specimen per minute or 1 ± 0.1 mm (0.04 ± 0.004 in.)/min, whichever is greater or as agreed by the user and manufacturer.

9.4 Use crosshead movement as a measure of deformation. If an automatic recorder is not used, measure the deformation in increments no greater than 0.5 % of the original thickness of the specimen. At each measurement, record the deformation and the corresponding load.

9.5 Continue until a yield point is reached and/or until the maximum acceptable deformation limit has been reached, whichever occurs first.

9.6 The test specimen should then be unloaded and removed from the loading mechanism.

9.7 Repeat the above procedures until five specimens are tested.

10. Calculation

10.1 If an automatic recorder was not used, construct a load-deformation curve from the incremental values obtained in accordance with 9.4.

10.2 In a typical load-deformation curve (Fig. 2) there is a toe region, *AC*, that may not represent a property of the material. It is an artifact caused by the alignment or seating of the specimen. If such a circumstance arises, in order to obtain correct values of such parameters as strain, yield point, etc., this artifact must be compensated for to give the corrected zero point on the deformation axis. Using a straightedge, carefully extend to the zero force line the steepest portion of the force-deflection or force-strain curve. This establishes the "zero deformation" or "zero strain" points (Point *B* in Fig. 2). Measure all distances for deformation or strain calculations from this point.

10.2.1 If there is a compressive yield point (as Point *Y* in Fig. 2), read the load and measure the specimen deformation (distance *B-D*). Calculate the residual thickness of the specimens at various fixed loads in addition to the yield point. Follow this with a report that indicates the values of both yield and residual thickness at various loads. These results can be reported in a graph or table.

10.2.2 Calculate the compressive stress by dividing the load at the compressive yield point by the initial horizontal cross-sectional area of the specimen. For geosynthetics with a repeating pattern of discrete support points, it may be more accurate to obtain the load per unit area by dividing the load by the number of support points in the specimen and multiply by the number of support points per square metre. Express the result in kPa (PSF).

10.2.3 For inclined plates, the normal load should first be calculated using the equation listed in Fig. 1.

$$N = P\cos\alpha \quad (1)$$

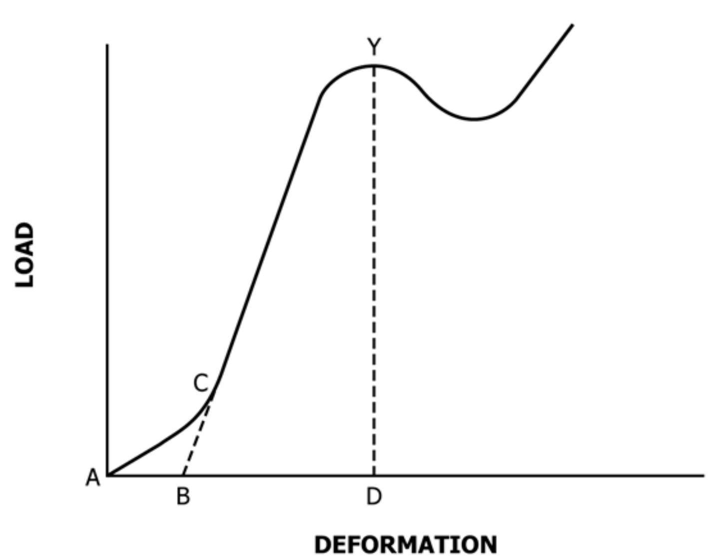

FIG. 2 Typical Load-Deformation Curve

where:

N = normal load,
P = applied load, and
α = angle of plate(s), degrees.

10.3 The compressive stress with the corresponding compressive strain shall be plotted for each test.

10.4 The compressive yield point shall be reported as the arithmetic mean and minimum of the five tests.

NOTE 7—Not all geosynthetics exhibit a well-defined compressive yield point. In such cases, if a compressive stress value is needed for comparative purposes, use a strain value agreed upon by the purchaser and buyer. Such a value might be the point where there is a significant change in the slope of the stress-strain curve, as shown by the two curves in Fig. 3.

11. Report

11.1 The report should include the following:

11.1.1 The description of the type of geosynthetic or geosynthetics tested,

11.1.2 The lot or production unit represented,

11.1.3 The dimensions and number of discrete support points (if applicable) of the test specimens. If applicable, the number of discrete support points per unit area of the geosynthetic,

11.1.4 The test data, including initial thickness; cross-sectional area; rate of deformation; and the deformations, strains, and corresponding stresses,

11.1.5 Angle of loading and description of roughened or ribbed surface on inclined plates,

11.1.6 Test curves expressing the compressive load (stress) as a function of the deformation,

11.1.7 The results of each specimen tested, plus the average of the compressive yield point of the geosynthetic, if the geosynthetic has a compressive yield point,

11.1.8 Date of test,

11.1.9 A statement of any unusual occurrences or departures from the suggested procedures, and

11.1.10 Machine type and date of last certification.

12. Precision and Bias

12.1 The precision of the procedure in this test method is being evaluated.

12.2 *Bias*—The value of the compressive yield point of geosynthetics can be defined only in terms of a test method. When this test method is the defining method, measurements of the compressive yield point have no bias.

13. Keywords

13.1 compression; deformation; geocomposite; index test; yield point

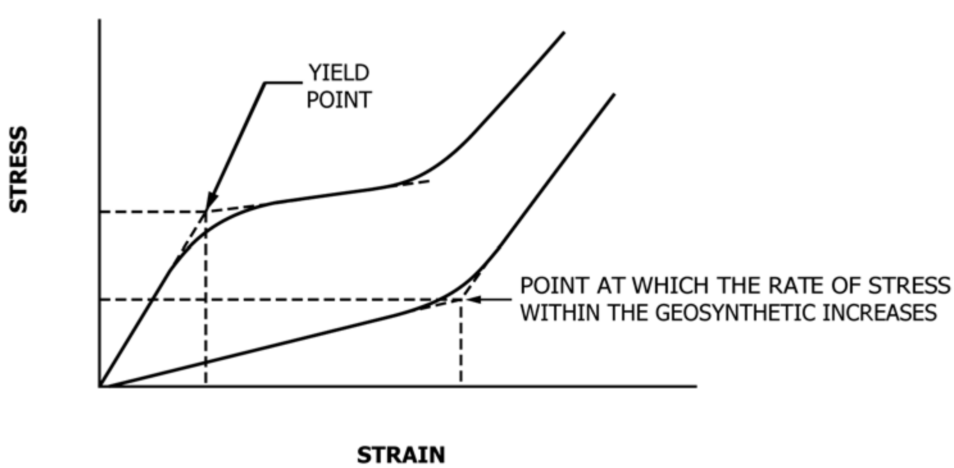

FIG. 3 Stress-Strain Curve