Designation: D 6454 – 99

Standard Test Method for Determining the Short-Term Compression Behavior of Turf Reinforcement Mats (TRMs)[1]

This standard is issued under the fixed designation D 6454; 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 The test method establishes the procedures for evaluation of the deformations of a turf reinforcement mat (TRM) 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. Results from this test method should not be considered as an indication of actual or long-term performance of the TRM in field applications.

1.2 Since these TRMs experience multidirectional compressive loadings in the field, this test method will not show actual field performance and should not be used for this specific objective. The evaluation of the results also should recognize that the determination of the short term single plane compressive behavior of geosynthetics does not reflect the installed performance of TRMs and, therefore, should not be used as the only method of product or performance specification.

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

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 4354 Practice for Sampling of Geosynthetics for Testing[2]

D 4439 Terminology for Geotextiles[2]

D 4716 Test Method for Determining the (In-Plane) Flow Rate Per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head[2]

D 5199 Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes[2]

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. **D 5199**

3.1.4 *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. **D 4439**

3.1.5 *index test, n*—a test procedure which may contain a known bias but which may be used to establish an order for a set of specimens with respect to the property of interest. **D 4439**

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

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

3.1.7 For definitions of terms relating to geotextiles, refer to Terminology D 4439.

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 TRMs 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 also may 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

[1] This test method is under the jurisdiction of ASTM Committee D-35 on Geosynthetics and is the direct responsibility of Subcommittee D35.05 on Geosynthetic Erosion Control.

Current edition approved August 10, 1999. Published October 1999.

[2] *Annual Book of ASTM Standards*, Vol. 04.09.

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 TRM in one plane.

5.1.1 The compressive yield point of TRMs 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 TRMs 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 TRMs but caution is advised because interlaboratory 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 statistically bias between their laboratories. Competent statistical assistance is recommended for the investigations of bias. As a minimum, two parties should take a group of test specimens from material shipped to project. The test specimens then should be assigned randomly 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/min or 1 mm/min, whichever is greater.

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/min or 1 mm/min, whichever is greater.

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

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 bottom 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 top movable, plate shall depend on the specimen dimensions and geometry. In general, both length and width of the top movable plate should each be at least 20 % greater than the length and width of the specimens.

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

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

6.6 *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 D 4354.

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 TRM 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.

7.3 *Test Specimens*—Cut five specimens from each unit in the laboratory sample with each specimen being at least 120 by 120 mm/mm^2 (4.7 by 4.7 $in.)^2$.

8. Conditioning

8.1 Bring the specimens to the moisture and temperature equilibrium in the atmosphere for testing permanent rolled erosion control products, that is, a temperature of 21+ 2°C (70 + 4°F) and a relative humidity of 60 + 10 %.

9. Procedure

9.1 Measure the length, width and thickness of the specimen to an accuracy of ± 1 %.

9.1.1 The nominal thickness shall be determined using Test Method D 5199.

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/min or 1 ± 0.1 mm (0.04± 0.004 in.)/min, whichever is greater or as agreed upon between 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, or until the maximum acceptable deformation limit has been reached, whichever occurs first.

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

9.7 Repeat the preceding procedures until five specimens are tested.

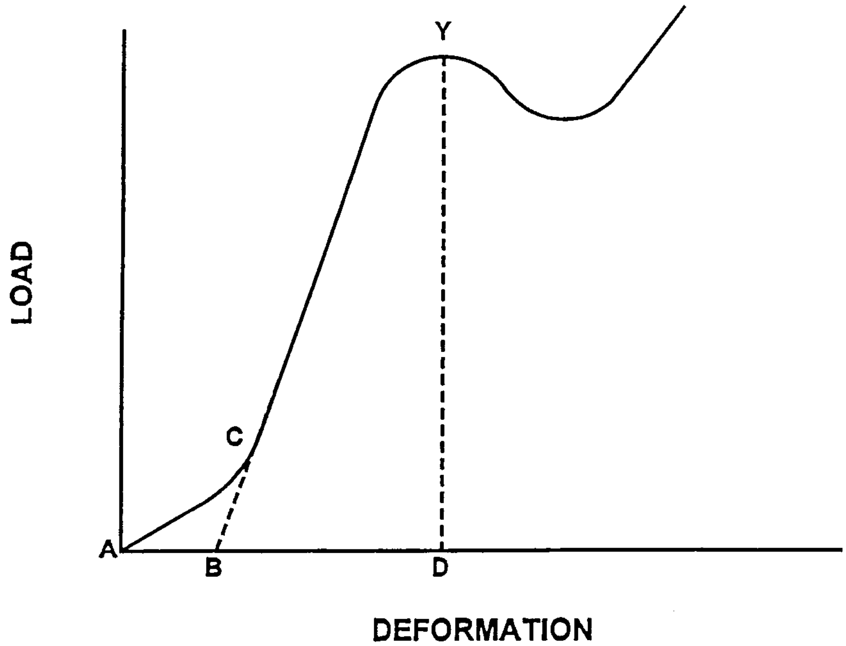

FIG. 1 Typical Load Deformation Curve

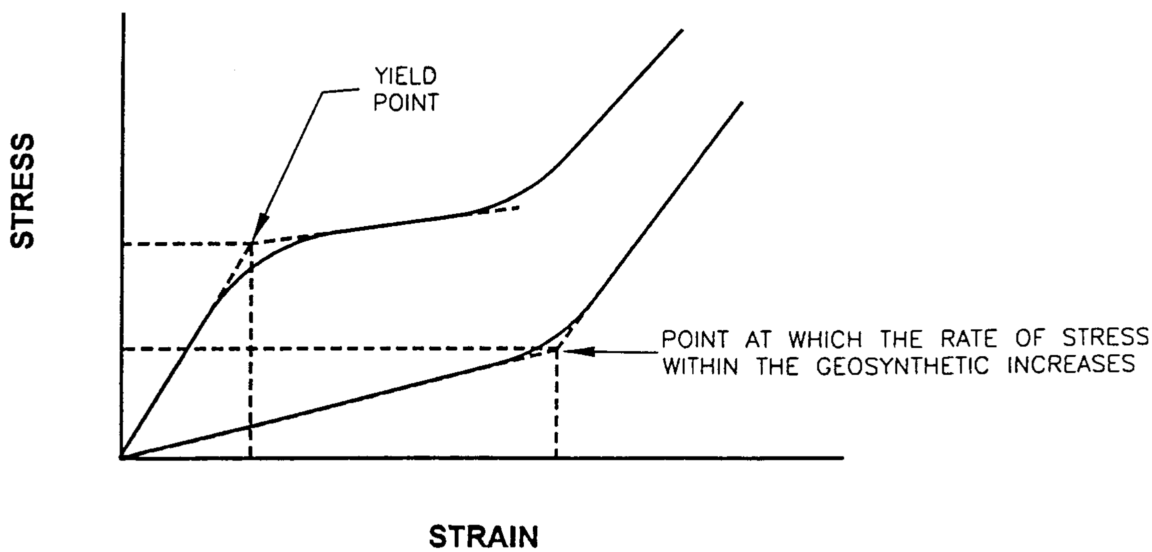

FIG. 2 Stress Strain Curve

10. Calculation

10.1 If an automatic recorder is 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 (see Fig. 1) 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. 1). 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. 1), 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.

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 4—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 between the purchaser and the 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. 2.

11. Report

11.1 Report the following information:

11.1.1 The description of the type of TRM tested.

11.1.2 The lot or production unit represented.

11.1.3 The dimensions of the test specimens.

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

11.1.6 The results of each specimen tested, plus the average of the compressive yield point of the TRM, if the TRM has a compressive yield point.

11.1.7 Date of test.

11.1.8 A statement of any unusual occurrences or departures from the suggested procedures.

11.1.9 Machine type and date of last certification.

12. Precision and Bias

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

12.2 *Bias*—The value of the compressive yield point of TRMs 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