Designation: D6524/D6524M – 16

Standard Test Method for Measuring the Resiliency of Turf Reinforcement Mats (TRMs)[1]

This standard is issued under the fixed designation D6524/D6524M; 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 resiliency or recovery of turf reinforcement mats (TRMs) after they have been subjected to three cycles of loading at 689 kPa [100 psi] for 1 min/per cycle.

1.2 This test method does not provide resiliency values for TRMs under variable normal compressive stresses. This test method determines nominal resiliency.

1.3 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

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:*[2]

D123 Terminology Relating to Textiles

D4354 Practice for Sampling of Geosynthetics and Rolled Erosion Control Products(RECPs) for Testing

D4439 Terminology for Geosynthetics

3. Terminology

3.1 *Definitions:*

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

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

3.1.3 *turf reinforcement mat (TRM), n*—a long-term nondegradable rolled erosion control product composed of UV stabilized, nondegradable, synthetic fibers, nettings, or filaments, or combination thereof, processed into three-dimensional reinforcement matrices.

3.2 For definitions of other textile terms used in this test method, refer to Terminology D123.

3.3 For definitions of other terms relating to geotextiles and geomembranes used in this test method, refer to Terminology D4439.

4. Summary of Test Method

4.1 The nominal resiliency of TRMs is determined by observing the thickness of the TRM before and after it is subjected to three cycles of loading at 689 kPa [100 psi] for 1 min⁄cycle.

5. Significance and Use

5.1 Resiliency may be used to control the quality of many TRMs. Resiliency may be indicative of a TRM's ability to retain original configuration after exposure to the stresses which may be exerted during manufacture, shipping, and installation. Resiliency is not generally indicative of field performance.

5.2 The resiliency of TRMs may vary considerably depending on the pressure applied to the specimen during loading cycles. To minimize variation, specific sample size and applied pressure are indicated in this test method to ensure all results are comparable.

5.3 To determine the effect of different pressure loadings on the final thickness of TRMs, use this test method.

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

5.4.1 In a 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 D35.05 on Geosynthetic Erosion Control.

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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.

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 date and an acceptable probability level chosen by the two begun. If bias is found, either its cause must corrected, or the purchaser and be found and interpret future tests in supplier must agree to 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 be affected by the thickness of the TRMs following the time when they are rolled up on rolls shipped and stored.

6. Apparatus

6.1 *Thickness Testing Instrument*—The thickness gauge shall have a base (or anvil) and a free-moving presser foot plate whose planar faces are parallel to each other to <0.1 mm. A gauge with a 150-mm [6-in.] diameter presser foot, the base shall extend at least 10 mm in all directions further than the edge of the approximately 17 500-mm^2 circular presser foot, shall be used for measurements of TRMs. The instruments must be capable of measuring a maximum thickness of at least 25 mm [1 in.] to an accuracy of +0.2 mm. The gauges shall be constructed to permit gradual application of pressure to a specific force of 0.2 + 0.02 kPa [0.029 + 0.003 psi] for TRMs. Dead weight loading may be used.

NOTE 2—Due to compressibility of many TRMs, 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 in accordance with Practice D4354.

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.

7.4 *Test Specimens*—Cut ten 102 by 102-mm [4 by 4 in.] test specimens from the sample. Handle specimens in a manner to avoid the loss of loose filler and weaving components.

7.5 *Number of Specimens*—Unless otherwise agreed upon, as when provided in an applicable material specification, 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 this test method, calculate the required number of specimens for the machine and cross-machine directions as follows:

$$n = (tV/A)^2 \quad (1)$$

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 = 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 the moisture and temperature equilibrium in the atmosphere for testing TRMs, that is a temperature of 21± 2°C [70 ± 4°F] and a relative humidity of 60 ± 10 %.

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 With force applied to the presser 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

TABLE 1 Values of Student's *t* for One-Sided Limits and the 95 % Probability

df	One-Sided	df	One-Sided	df	One-Sided
1	6.314	11	1.796	22	1.717
2	2.920	12	1.782	24	1.711
3	2.353	13	1.771	26	1.706
4	2.132	14	1.761	28	1.701
5	2.015	15	1.753	30	1.697
6	1.943	16	1.746	40	1.684
7	1.895	17	1.740	50	1.676
8	1.860	18	1.734	60	1.671
9	1.833	19	1.729	120	1.658
10	1.812	20	1.725	∞	1.645

the base under the presser foot, and bring the presser foot into contact with the material. After the full force has been applied to the presser foot for 5 s against the specimen, record the thickness value, T_i, to the nearest 0.002 mm and remove the specimen from the test device.

9.4 Place the specimen under a constant normal compressive load of 689 kPa [100 psi], assuming that the load is applied evenly over the entire surface area of the test specimen.

NOTE 3—Hydraulic presses have been found to be successful for load application.

9.4.1 Apply three loading cycles that consist of 1 min under load and 1 min unloaded.

9.4.2 After the three loading cycles, allow the specimen to recover for 30 min.

9.5 Measure the final thickness, *Tf* (mm), in accordance with 9.3.

9.6 Repeat the test method for each of the remaining specimens.

10. Calculation

10.1 Calculate the percent thickness recovery, resiliency, for each specimen:

$$\text{Resiliency} = (T_f / T_i) \times 100 \quad (2)$$

10.2 Calculate the average resiliency for all specimens.

11. Report

11.1 Report the following information for nominal resiliency:

11.1.1 Project, type of TRM tested, and method of sampling,

11.1.2 Name or description of thickness and pressure loading 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 resiliency,

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

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

12. Precision and Bias

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

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

13. Keywords

13.1 recovery; resiliency; thickness; turf reinforcement mat, TRM