Designation: D6575/D6575M − 16

Standard Test Method for Determining Stiffness of Geosynthetics Used as Turf Reinforcement Mats (TRMs)[1]

This standard is issued under the fixed designation D6575/D6575M; 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 determination of the stiffness of geosynthetics used as Turf Reinforcement Mats (TRM).

1.2 The method is applicable to TRMs of any fiber content and any number of components.

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
D1388 Test Method for Stiffness of Fabrics
D1776/D1776M Practice for Conditioning and Testing Textiles
D4354 Practice for Sampling of Geosynthetics and Rolled Erosion Control Products(RECPs) for Testing
D4439 Terminology for Geosynthetics
D6566 Test Method for Measuring Mass per Unit Area of Turf Reinforcement Mats
E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods
E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

2.2 *Federal Standards:*[3]
CCC-T-191b Textile Test Methods No. 5206.2

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *bending length, n:*

3.1.1.1 *general, adj*—a measure of the interaction between geosynthetic weight and geosynthetic stiffness as shown by the way in which a geosynthetic bends under its own weight. It reflects the stiffness of a geosynthetic when bent in one plane under the force of gravity, and is one component of drape.

3.1.1.2 *Discussion*—Bending length is called drape stiffness in Federal Specification CCC-T-191b.

3.1.1.3 *specific, adj*—the cube root of the ratio of the flexural rigidity to the mass per unit area.

3.1.2 *flexural rigidity, n:*

3.1.2.1 *general, adj*—resistance to bending.

3.1.2.2 *Discussion*—Resistance to bending or "flexural rigidity" is called flex stiffness in Federal Specification CCC-T-191b.

3.1.2.3 *specific, adj*—the couple on either end of a sample of unit width bent into unit curvature in the absence of any tension.

3.1.2.4 *Discussion*—The methods measure the bending length. Flexural rigidity is calculated directly by multiplying the cube of the bending length by the weight per unit area (see 3.1.1.3).

3.1.3 *stiffness, n*—resistance to bending.

3.2 *Definitions*—For definitions of other textile or geosynthetic terms used in this test method, refer to Terminologies D123 and D4439.

4. Significance and Use

4.1 In general this test method is adapted from tests developed for woven fabrics (previously designated as Test Method D1388).

4.2 The cantilever test method may not be suitable for testing products that are very limp or have a marked tendency to curl or twist at a cut edge.

[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.

[3] Available from U.S. Government Publishing Office, 732 N. Capitol St., NW, Washington, DC 20401-0001, http://www.gpo.gov.

Cantilever Method

5. Summary of Method

5.1 A specimen of the TRM is slid in a direction parallel to its long dimension, so that its end projects from the edge of a horizontal surface. The length of overhang is measured when the tip of the test specimen is depressed under its own weight to the point where the line joining the tip to the edge of the platform makes an angle of 41.5° with the horizontal. One half of this length is the bending length of the specimen. The cube of this quantity multiplied by the weight per unit area of the geosynthetic is the flexural rigidity.

5.2 This test method is known also as the Single Cantilever Test.

6. Apparatus

6.1 *Stiffness Tester,* having the following parts:

6.1.1 *Horizontal Platform,* with a minimum area of 18 by 12 in. [457.2 by 304.8 mm] and having a smooth low-friction, flat surface such as polished metal or plastic. A leveling bubble shall be incorporated in the platform, or be available for verification that the horizontal platform is level.

6.1.2 *Indicator,* inclined at an angle of 41.5° below the plane of the platform surface.

6.1.3 *Weight,* consisting of a metal bar not less than 4 by 18 in. [101.6 by 457.2 mm] by about ⅛ in. [3 mm] thick.

6.1.4 *Scale and Pointer,* to measure the length of the overhang.

7. Conditioning

7.1 For tests made as directed in 9.1 – 9.5, bring the specimens to a moisture equilibrium in the atmosphere for testing TRMs, that is a temperature of 70 ± 4°F [21 ± 2°C] and relative humidity of 60 ± 10 %. See Practice D1776/D1776M.

8. Selection and Preparation of Specimens

8.1 Cut test specimens 4 in. wide by a minimum of 18 in. long [101.6 by 457.2 mm]; longer specimens may be needed to obtain a measurement. Cut four specimens with the long direction parallel to the machine direction and four with the long direction parallel to the transverse (or cross-machine) direction. If the geosynthetic is not uniform or a higher degree of precision is required, more may be tested. Vary cutting the specimens in such a way that the machine direction specimens do not contain the same machine direction yarns/filaments for the machine direction tests and cut the cross-machine direction specimens so that separate cross-machine direction yarns/filaments are contained in each. Avoid selvages, end pieces, and creased or folded places, and handle the specimens as little as possible. Additional conditioning may be needed to remove curl from rolled geosynthetics. See Practice D4354.

NOTE 1—Some TRMs are constructed from several component materials and sample preparation must be performed in such a way as to maintain the structural integrity of the product. Procedures found to be successful for cutting test specimens from TRMs include the use of hot knives to seal the edges and the use of bags and slip covers to keep all components together during sample preparation. The method of cutting the specimen should be included in the report.

9. Procedure

9.1 Make tests on conditioned specimens in the standard atmosphere for testing.

9.2 Set the tester on a table or bench so that the horizontal platform and inclined reference lines are at eye level. Adjust the platform so that it is horizontal as indicated by the leveling bubble.

9.3 Place a specimen on the platform with the weight on top of it so that the leading edges coincide. Holding the weight in a horizontal plane, slide the specimen and weight slowly and steadily until the leading edges project beyond the edge of the platform. Take the measurement of the overhang where the center of the leading edge of the specimen touches the incline. Do not measure specimens that twist more than 45°. Read the length of overhang from the scale to the nearest 1 mm.

9.4 Take four readings from each specimen, with each side up, first at one end and then the other.

9.5 Determine the mass per unit area according to Test Method D6566.

10. Calculation

10.1 Unless otherwise specified, average the four readings obtained from all the specimens cut parallel to the machine direction. Do the same for those cut parallel to the cross-machine direction. In some cases it may be of interest to differentiate between the sides of the geosynthetic by averaging those readings made with the face side up separately from those with the reverse side up. If this is done, specify the direction of bending. Call these averages the "length of overhang," and express them in centimetres. Calculate the bending length, c, in centimetres, and the flexural rigidity, G, in mg/cm by Eq 1 and 2:

$$\text{Bending length, } c = L_o/2 \tag{1}$$

where:

L_o = length of overhang, cm.

$$\text{Flexural rigidity, } G = W \times (L_o/2)^3 = W \times c^3 \tag{2}$$

where:

W = weight per unit area, mg/cm^2.

NOTE 2—To obtain the weight in mg/cm^2, multiply oz/yd^2 by 3.39. Federal Specification CCC-T-191b gives flexural rigidity in in.-lb. To convert in.-lb to mg-cm, multiply by 1.15×10^6.

11. Report

11.1 Report the following information:

11.2 Report to three significant figures the flexural rigidity of the machine direction and cross-machine direction separately. If an overall average figure for the geosynthetic is required, calculate the geometric mean of these two values by Eq 3:

$$G_o = (G_{MD} G_{CD})^{1/2} \tag{3}$$

where:

G_o = overall flexural rigidity,

G_{MD} = machine direction flexural rigidity, and
G_{CD} = cross-machine flexural rigidity.

12. Precision and Bias[4]

12.1 *Precision*—The precision of this test method is based on an interlaboratory study of Test Method D6575, conducted in 2013. Five laboratories participated in this study. Each of the labs reported three replicate test results for three different types of mats. Every test result reported represents an individual determination. Except for the use of only five laboratories, Practice E691 was followed for the design and analysis of the data; the details are given in ASTM Research Report No. RR:D35-1019.

12.1.1 *Repeatability (r)*—The difference between repetitive results obtained by the same operator in a given laboratory applying the same test method with the same apparatus under constant operating conditions on identical test material within short intervals of time would in the long run, in the normal and correct operation of the test method, exceed the following values only in one case in 20.

12.1.1.1 Repeatability can be interpreted as the maximum difference between two results, obtained under repeatability conditions, that is accepted as plausible due to random causes under normal and correct operation of the test method.

12.1.1.2 Repeatability limits are listed in Tables 1 and 2.

12.1.2 *Reproducibility (R)*—The difference between two single and independent results obtained by different operators applying the same test method in different laboratories using different apparatus on identical test material would, in the long run, in the normal and correct operation of the test method, exceed the following values only in one case in 20.

12.1.2.1 Reproducibility can be interpreted as the maximum difference between two results, obtained under reproducibility conditions, that is accepted as plausible due to random causes under normal and correct operation of the test method.

12.1.2.2 Estimated reproducibility limits are listed in Tables 1 and 2.

12.1.3 The above terms (repeatability limit and reproducibility limit) are used as specified in Practice E177.

12.1.4 Any judgment in accordance with statements 12.1.1 and 12.1.2 would normally have an approximate 95 % probability of being correct, however the precision statistics obtained in this ILS must not be treated as exact mathematical quantities which are applicable to all circumstances and uses. The limited number of materials tested and laboratories reporting results guarantees that there will be times when differences greater than predicted by the ILS results will arise, sometimes with considerably greater or smaller frequency than the 95 % probability limit would imply. The repeatability limit and the reproducibility limit should be considered as general guides, and the associated probability of 95 % as only a rough indicator of what can be expected.

12.2 *Bias*—At the time of the study, there was no accepted reference material suitable for determining the bias for this test method, therefore no statement on bias is being made.

12.3 The precision statement was determined through statistical examination of 90 results, from five laboratories, on three materials.

12.3.1 To judge the equivalency of two test results, it is recommended to choose the mat material closest in characteristics to the test material.

[4] Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:D35-1019. Contact ASTM Customer Service at service@astm.org.

TABLE 1 Stiffness—Machine Direction (mg-cm)

Material	Average[A]	Repeatability Standard Deviation	Reproducibility Standard Deviation	Repeatability Limit	Reproducibility Limit
	$\bar{x}$	S_r	S_R	r	R
Double Net Blanket	17047	3833	9705	10732	27173
Double Net TRM #1	47758	14032	27718	39290	77610
Double Net TRM #2	30694	11958	15501	33483	43402

[A] The average of the laboratories' calculated averages.

TABLE 2 Stiffness—Cross-Machine Direction (mg-cm)

Material	Average[A]	Repeatability Standard Deviation	Reproducibility Standard Deviation	Repeatability Limit	Reproducibility Limit
	$\bar{x}$	S_r	S_R	r	R
Double Net Blanket	18808	2835	7513	7937	21036
Double Net TRM #1	30226	12208	18072	34182	50601
Double Net TRM #2	25720	9963	13458	27897	37683

[A] The average of the laboratories' calculated averages.