Designation: D1388 – 23

Standard Test Method for Stiffness of Fabrics[1]

This standard is issued under the fixed designation D1388; 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.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope*

1.1 This test method covers the measurement of stiffness properties of fabrics. Bending length is measured and flexural rigidity is calculated. Two procedures are provided.

1.1.1 *Option A*—Cantilever Test, employing the principle of cantilever bending of the fabric under its own mass.

1.1.2 *Option B*—Heart Loop Test, employing the principle of a loop formed in a fabric strip and hung vertically.

1.2 This test method applies to most fabrics including woven fabrics, air bag fabrics, blankets, napped fabrics, knitted fabrics, layered fabrics, pile fabrics. The fabrics may be untreated, heavily sized, coated, resin-treated, or otherwise treated.

1.2.1 This method may be used to determine the stiffness of nonwoven materials (for example, hydroentangled, dry laid, needlepunch, resin bonded, thermal, and wet laid) or refer to Test Method D5732. To determine the stiffness of medical textiles (for example, surgical mesh, films, and membranes), refer to Test Method F3260.

NOTE 1—The formula to calculate flexural rigidity in D5732-95 (2001) is incorrect and should not be used. Utilize the formula presented in 11.5 of Test Method D1388.

1.3 *Units*—The values stated in SI units are to be regarded as the standard. The values given in parentheses after SI units are provided for information only and are not considered 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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D123 Terminology Relating to Textiles

D1776 Practice for Conditioning and Testing Textiles

D2904 Practice for Interlaboratory Testing of a Textile Test Method that Produces Normally Distributed Data (Withdrawn 2008)[3]

D2906 Practice for Statements on Precision and Bias for Textiles (Withdrawn 2008)[3]

D3776 Test Methods for Mass Per Unit Area (Weight) of Fabric

D4850 Terminology Relating to Fabrics and Fabric Test Methods

D5732 Test Method for Stiffness of Nonwoven Fabrics Using the Cantilever Test (Withdrawn 2008)[3]

F3260 Test Method for Determining the Flexural Stiffness of Medical Textiles

3. Terminology

3.1 For all terminology relating to D13.59, Fabric Test Methods, General, refer to Terminology D4850.

3.1.1 The following terms are relevant to this standard: bending length, cross-machine direction, (CD), fabric, flexural rigidity, machine direction, (MD), stiffness.

NOTE 2—Machine direction (MD) may represent wale and warp directions and cross-machine direction (CD) may represent course and weft directions in knit fabrics or woven fabrics or both.

3.2 For all other terminology related to textiles, refer to Terminology D123.

4. Summary of Test Method Options

4.1 *Option A, Cantilever Test*—A specimen is slid at a specified rate in a direction parallel to its long dimension, until

[1] This test method is under the jurisdiction of ASTM Committee D13 on Textiles and is the direct responsibility of Subcommittee D13.60 on Fabric Physical Test Methods B.

Current edition approved Aug. 1, 2023. Published August 2023. Originally approved in 1956. Last previous edition approved in 2018 as D1388–18. DOI: 10.1520/D1388-23.

[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] The last approved version of this historical standard is referenced on www.astm.org.

***A Summary of Changes section appears at the end of this standard**

its leading edge projects from the edge of a horizontal surface. The length of the overhang is measured when the tip of the specimen is depressed under its own mass to the point where the line joining the tip to the edge of the platform makes a 0.724 rad (41.5°) angle with the horizontal. From this measured length and the specimen's fabric mass per unit area, the bending length and flexural rigidity are calculated.

NOTE 3—When the tip of the specimen reaches a plane inclined at 41.5° below the horizontal, the overhanging length is then twice the bending length.

4.1.1 The Cantilever Test option is the preferred procedure because it is simpler to perform. It is, however, not suitable for very limp fabrics or those that show a marked tendency to curl or twist at a cut edge (see Fig. 1 and Note 12).

4.2 *Option B, Heart Loop Test*—A strip of fabric is formed into a heart-shaped loop. The length of the loop is measured when it is hanging vertically under its own mass. From this measured length and the specimen's fabric mass per unit area, the bending length and flexural rigidity are calculated.

4.2.1 The Heart Loop Test option is suitable for fabrics that show a tendency to curl or twist.

4.3 The two methods will not necessarily give the same numerical values or rank different types of fabrics in the same order. Both options can provide a correlation with a subjective evaluation of a given fabric type. That is, a higher number represents a stiffer fabric.

5. Significance and Use

5.1 In general, these procedures are more suitable for testing woven fabrics than knit fabrics.

5.2 Both test options in this test method are considered satisfactory for acceptance testing of commercial shipments since current estimates of between-laboratory precision are acceptable and the method is used extensively in the trade for acceptance testing.

5.2.1 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 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 from a lot of material of the type in question. 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 appropriate statistical analysis and an acceptable probability level chosen by the two parties before testing is begun. If a bias is found, either its cause must be found and corrected or the purchaser and the supplier must agree to interpret future test results with consideration to the known bias.

5.3 The stiffness of a fabric may change with storage.

5.4 No evidence has been found showing that bending length is dependent on the width of the test specimen. The tendency for specimens to curl or twist will affect the result, because of the rigidity provided at the edge of the specimen. Consequently, the wider the strip, the less important is the edge effect. For fabrics having only a slight tendency to curl, a 2.5 cm wide strip has been found to be satisfactory. As the tendency to curl increases, this width may be increased (see Note 10).

5.5 This method differs from Test Method F3260 which requires tracking of sample surface orientation, and is used to evaluate absorbable and partially absorbable medical textiles.

6. Apparatus

6.1 *Option A*—Cantilever Bending Tester[4] (Fig. 2).

6.1.1 *Horizontal Platform,* with a minimum area of 38 mm by 200 mm (1.5 in. by 8 in.) and having a smooth, low-friction, flat surface such as polished metal or plastic.

6.1.2 *Bend Angle Indicator,* inclined at an angle of 0.724 rad ± 0.01 rad (41.5° ± 0.5°) below the plane of the horizontal platform surface.

6.1.3 *Movable Specimen Slide,* consisting of a metal bar not less than 25 mm by 200 mm (1 in. by 8 in.) by approximately 3 mm (⅛ in.) thick and having a mass of 270 g ± 5 g (0.6 lb ± 0.01 lb). A motorized specimen feed unit set to 120 mm/min ± 5 % (4.75 in./min ± 5 %) may be used.

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

NOTE 4—The original instrument this method is based on included a scale demarcated in centimeters of bending length.

6.2 *Cutting Die (optional)*—25 mm ± 1 mm by 200 ± 1 mm (1 in. ± 0.04 in. by 8 in. ± 0.04 in.).

6.3 *Option B*—Heart Loop Tester (Fig. 3.)

[4] Apparatus is available commercially.

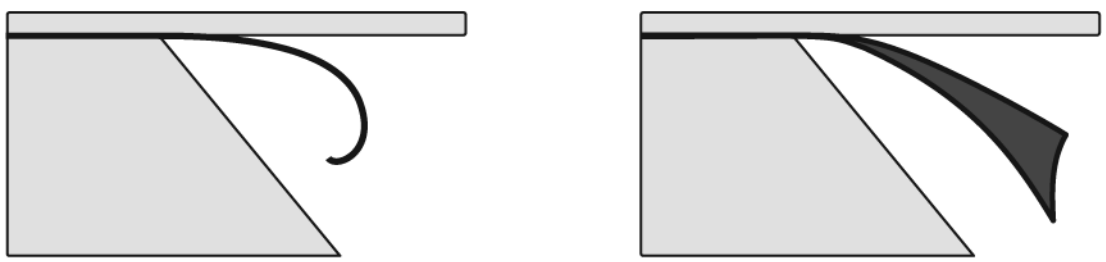

FIG. 1 Fabric Examples Not Suitable for Cantilever Test

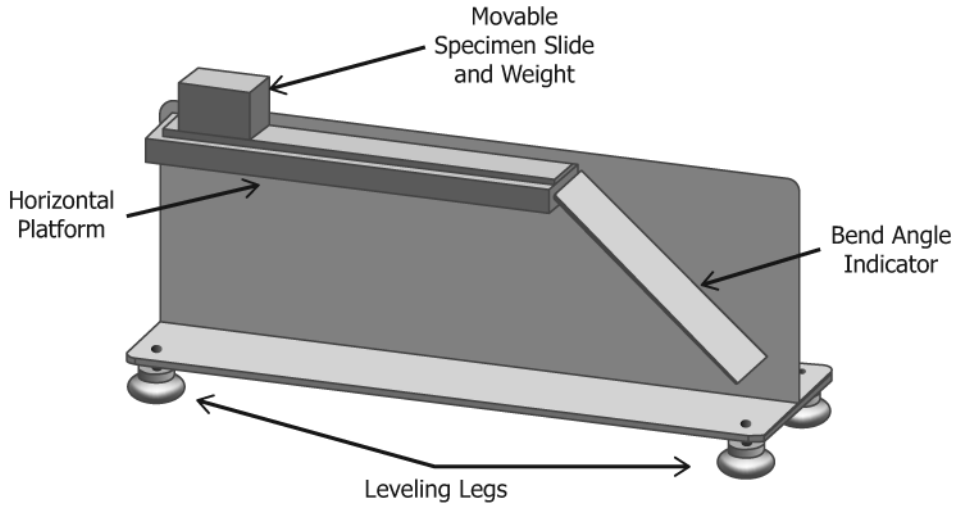

FIG. 2 Example of a Cantilever Bending Tester

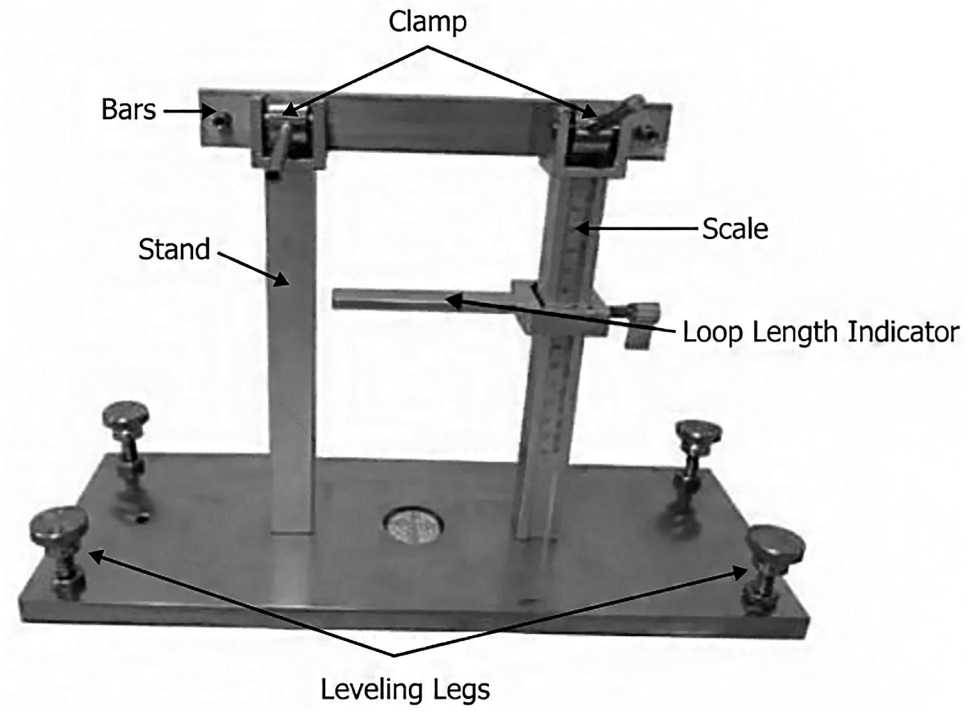

FIG. 3 Example of a Heart Loop Tester

6.3.1 *Clamp and Stand,* for hanging the specimen.

NOTE 5—A convenient method for mounting and measuring the specimen involves the use of two bars 25 mm by 75 mm by 3 mm (1 in. by 3 in. by 0.125 in.), to which the strip is fastened and a clip for holding these bars and the attached strip in a suitable position in front of scale.

6.3.2 *Scale,* suitably mounted on the stand for measuring the length of the specimen loop and calibrated either in cm (in.) or directly in bending length.

NOTE 6—If a constant strip length is adopted, the scale may be calibrated to read directly in units of bending length.

6.4 *Pressure Sensitive Tape.*

6.5 *Jig (optional),* constructed to allow positioning of the two bars with their inner edges parallel and at a distance from each other equal to the selected strip length.

6.6 *Balance,* having a capacity and sensitivity to weigh within ± 0.1 % of the specimen weight being tested.

7. Sampling and Test Specimens

7.1 *Lot Sample*—As a lot sample for acceptance testing, randomly select the number of rolls or pieces of fabric directed in an applicable material specification or other agreement between the purchaser and the supplier. Consider the rolls or