Designation: D7811 – 13 (Reapproved 2017)

Standard Test Method for Bow and Skew Using a Measuring Tool[1]

This standard is issued under the fixed designation D7811; 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 is used to determine the bow and skew of woven and knitted fabrics over a fixed distance, using a measuring tool.

1.2 This test method is useful when a small specimen or cut parts need to be evaluated for bow and skew, provided a warp or fill, or both, reference line is available, to aid in aligning the tool.

1.3 Test Method D3882 may be used when measuring bow and skew in fabric in rolls. However, results obtained with D3882 may not be comparable with results obtained by this test method.

1.4 There is no known ISO equivalent standard.

1.5 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.6 *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.*

1.7 *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

D3882 Test Method for Bow and Skew in Woven and Knitted Fabrics

D3990 Terminology Relating to Fabric Defects

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

3. Terminology

3.1 For all terminology related to fabric defect terms, refer to Terminology D3990.

3.1.1 The following terms are relevant to this standard: bow, double bow, double hooked bow, double reverse bow, hooked bow, knitted fabric, skew, standard atmosphere for testing textiles.

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

4. Summary of Test Method

4.1 A straightedge is placed across the fabric between two points at which a marked filling yarn, knitted course, designated printed line, or designated design meets the two selvages or edges. The greatest distance between the straightedge and the marked filling line, knitted course, designated printed line, or designated design is measured parallel to the selvage.

5. Significance and Use

5.1 This test method provides a standard procedure for obtaining data for research and development, quality control, acceptance and rejection under specifications, and for special purposes.

5.2 The data obtained by this test method is applicable to the material under the conditions of this particular test and is not necessarily the same as obtained under other environments in use.

5.3 This test method is considered satisfactory for acceptance testing of commercial shipments.

5.4 If there are differences of practical significance between reported test results for two laboratories (or more), comparative tests should be performed to determine if there is a statistical bias between them, using competent statistical assistance. As a minimum, the test samples to be used are as

[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 Test Methods, Specific.

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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.

homogeneous as possible, are drawn from the material from which the disparate test results were obtained, and are randomly assigned in equal numbers to each laboratory for testing. Other fabrics with established test values may be used for this purpose. The test results from the two laboratories should be compared using a statistical test for unpaired data, at a probability level chosen prior to the testing series. If a bias is found, either its cause must be found and corrected, or future test results must be adjusted in consideration of the known bias.

5.5 Bow or skew can be induced during fabric manufacturing, dyeing, tentering, finishing, or other operations where a potential exists for uneven distribution of tensions across the fabric width. Bow and skew are more visually displeasing in colored, patterned fabrics such as plaids and horizontal stripes rather than in solid colors because the contrast makes the distortion more prominent. These defects may cause sewing problems in such fabrics and draping problems in finished products. Wavy or sharp breaks in the bow line are more detrimental to the appearance of small specimens of a sewn assembly.

6. Apparatus

6.1 *Millimeter Rule,* graduated in 1-mm (1⁄16-in.) divisions.

6.2 *Test Fixture*—See Fig. 1 and Fig. 3. This tool, hereafter referred to as "bow and skew measurement tool" is to be used for each measurement.

6.2.1 Fig. 3 is a dimensioned drawing of bow and skew measurement tool.

6.3 *Bow Skew Measurement Tool Construction:*

6.3.1 Transparent material such as polycarbonate.

6.3.2 Thickness 3 to 5 mm.

6.4 *Flat Surface,* of sufficient area to lay the test specimen.

6.5 *Fabric Inspection Table (Optional) with sufficient lighting,* for fabric on rolls or bolts.

7. Interferences

7.1 None identified.

8. Sampling

8.1 When testing fabric in rolls, consider rolls to be the primary sampling units and select at least three areas from each roll for testing, excluding the first and last fifth of the roll. Select areas for testing at random, and no closer to one another than one fifth of the length of the roll.

8.2 For cut parts of sufficient size for testing (i.e. at least 400 mm in length), consider each part a test specimen, and test at least three randomly chosen specimens.

9. Calibration and Standardization

9.1 *Bow and Skew Measurement Tool Calibration:*

9.2 Bow Skew Measurement Tool is to be verified to Fig. 3 dimensions by using scale or rule traceable to NIST or equivalent national standard.

10. Conditioning

10.1 Condition the test specimens to moisture equilibrium for testing in the standard atmosphere for testing textiles in accordance with Practice D1776 or, if applicable, in the specified atmosphere in which the testing is to be performed.

10.2 When full rolls or bolts of fabric cannot be properly conditioned in a reasonable time with available facilities, perform the test without conditioning and report the actual

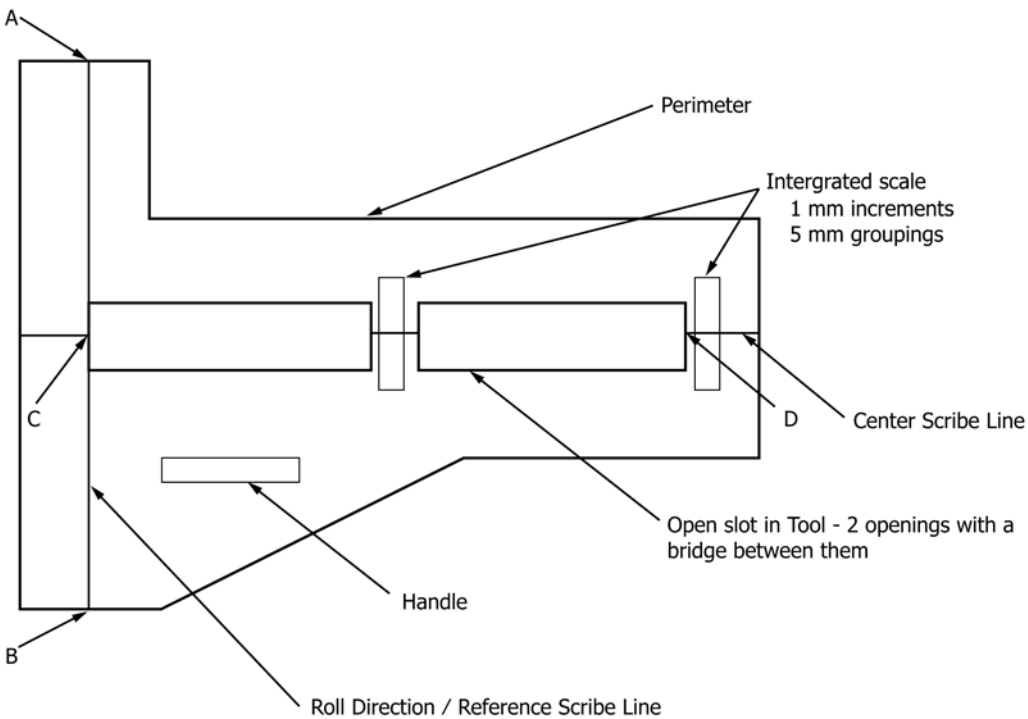

FIG. 1 Bow Skew Tool with Open Slot

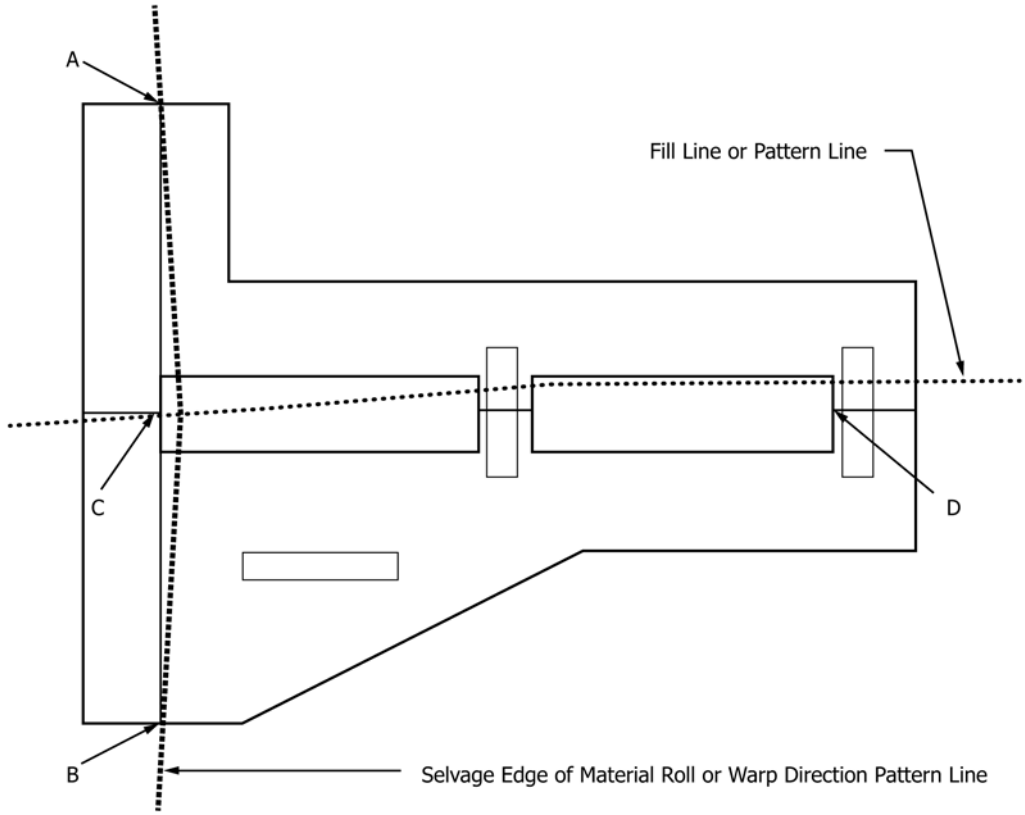

FIG. 2 Bow Skew Tool with Open Slot Lined Up to Material

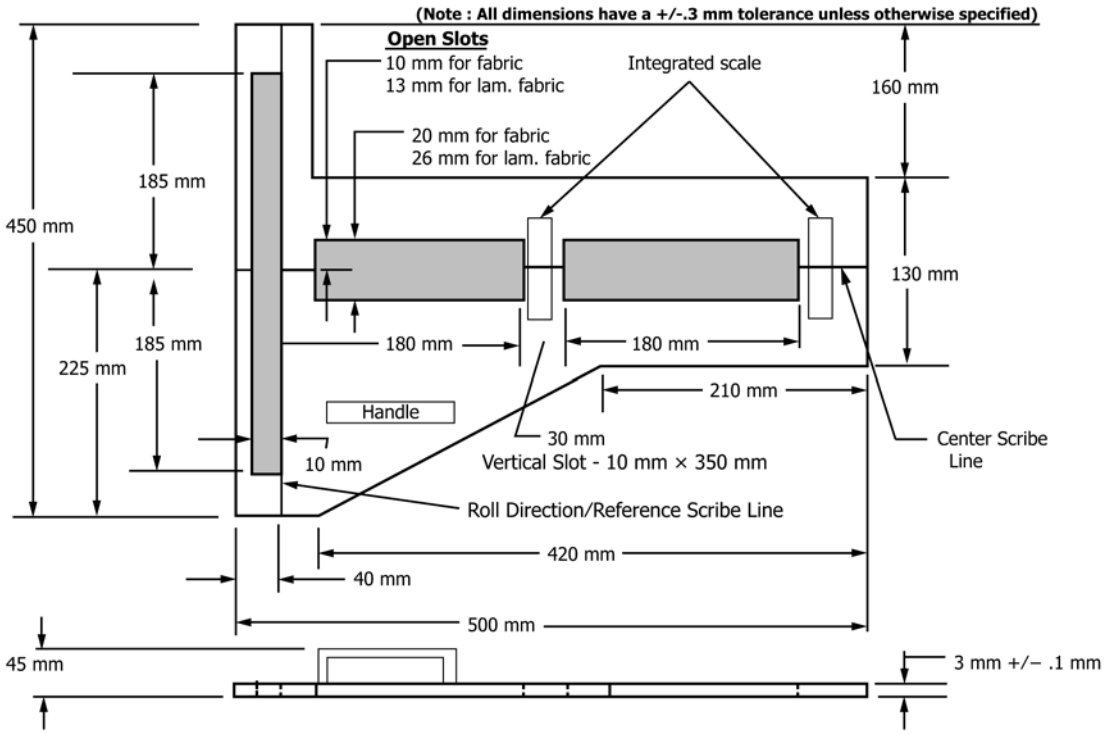

FIG. 3 Bow Skew Tool with Open Slots—Dimensioned

condition prevailing at the time of the test. Such results may not correspond with the results obtained when testing after conditioning.

10.3 Testing is to be conducted in an environment of 23 ± 2° C and 50 ± 5 % relative humidity.

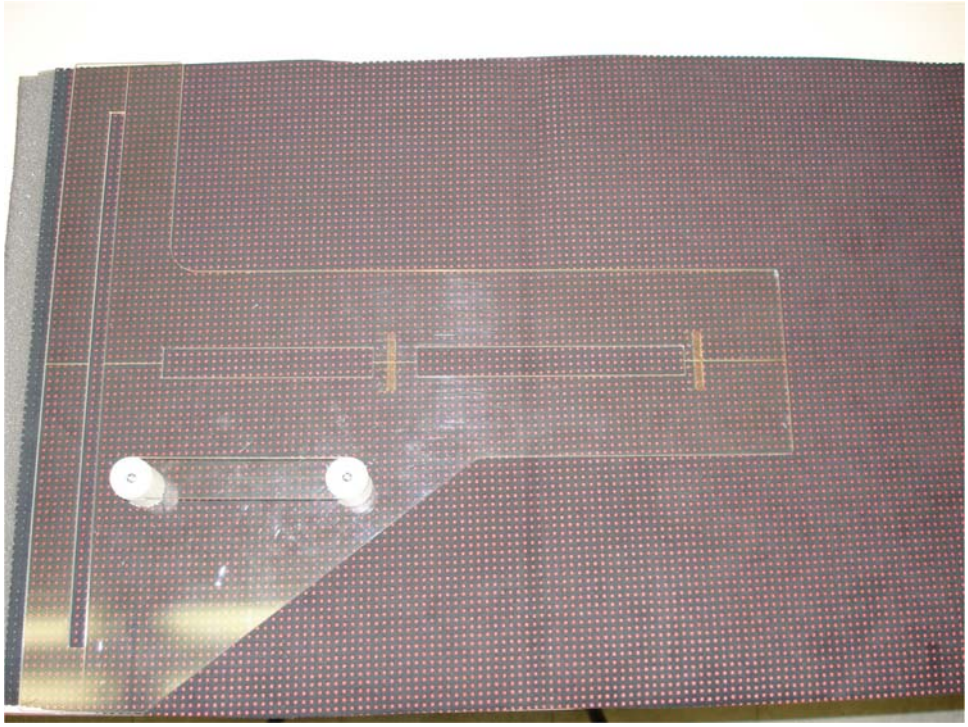

FIG. 4 Photograph of Test Tool (Typical)

10.4 Condition test specimens for 24 h in an environment of 23 ± 2° C and 50 ± 5 % relative humidity.

10.5 If test specimens are conditioned for less than 24 h, or under different conditions, note and report the alternative times/conditions used.

10.6 If the test specimen is tested in an environment other than the environment outlined in 10.3, note actual environmental conditions at the time of testing.

11. Procedure A—Using the Tool on Rolled Goods

11.1 Start by positioning the Bow and Skew Measurement Tool (reference Fig. 1 and Fig. 2) to the far left side of the unrolled material.

11.2 Line up line AB on the Bow and Skew Measurement Tool to the selvage edge of the material (selvage may curve away from Line AB – match points A & B to edge as shown in Fig. 2).

11.3 Position scribe line CD at point C to a chosen fill line or fill pattern of the material.

11.4 Recheck the positioning of the AB scribe line to the left edge of the material, repeat steps 11.1, 11.2, and 11.3 as needed.

11.5 Follow the fill line or pattern from point C to point D on the Tool.

11.6 Use the integrated scale at point D on the Bow and Skew Measurement Tool to measure the distance of the fill line or pattern from line CD at point D (if Bow is the major effect) and at the farthest point from line CD if Skew is the major effect – use integrated scale in the center of the tool if appropriate.

11.7 Record the measurement. The scale on the Bow and Skew Measurement Tool has 1 mm increments grouped in sections of 5 mm each totaling ±20 mm from Line CD.

11.8 Move the Bow and Skew Measurement Tool to the right so that point C is now located where point D was previously (Line CD is 400 mm which is the dimension that the Bow or Skew is to be measured over).

11.9 Line up point C on the same fill line or pattern that was chosen in step 11.3.

11.10 Position the Bow and Skew Measurement Tool so that Line AB is now located over a warp line or pattern instead of selvage edge (use method in step 11.2) if warp line or pattern is not straight.

11.11 Recheck that Line CD is on the correct fill line or pattern and recheck that Line AB is still on a warp line or pattern – repeat 11.9 and 11.10 as needed.

11.12 Follow the fill line or pattern from point C to point D on the Bow and Skew Measurement Tool.

11.13 Use the integrated scale at point D on the Bow and Skew Measurement Tool to measure the distance of the fill line or pattern from line CD at point D (if Bow is the major effect). If skew is the major effect, measure at the farthest point from line CD using the integrated scale in the center of the tool.

11.14 Record Data.[3]

11.15 Repeat steps 11.8 through 11.14 until the far right side of the unrolled material is reached (there will most likely be a left over portion of the material width less than 400 mm in length).

[3] If bow/skew is greater than 20 mm, report "bow/skew is greater than 20 mm."

11.16 Rotate the Bow and Skew Measurement Tool 180 degrees.

11.17 Repeat steps 11.1 through 11.7 but in a right to left orientation.

11.18 Record Data.[3]

12. Procedure B—Using the Tool on Cut Parts

12.1 Start by determining the machine direction (warp) of the pattern on the cut specimen. Orient that direction to run up and down as the operator looks at the specimen. The cross machine direction (fill) should run side to side.

12.2 Position the Bow and Skew Measurement Tool (reference Fig. 1) to the far left side of the cut specimen so that line AB follows a warp line on the left side of the cut specimen. This warp line should be at least 50 mm inboard of the specimen edge. The warp line may curve away from Line AB – match points A & B to the warp line (reference Fig. 2).

12.3 Position scribe line CD at point C to a chosen fill line or fill pattern on the material of the cut specimen.

12.4 Recheck the positioning of the AB scribe line to the warp line; repeat steps 12.2 and 12.3 as needed.

12.5 Follow the fill line or pattern from point C to point D on the Bow and Skew Measurement Tool.

12.6 Use the integrated scale at point D on the Bow and Skew Measurement Tool to measure the distance of the fill line or pattern from line CD at point D (if bow is the major effect). If skew is the major effect, measure at the farthest point from line CD using the integrated scale in the center of the tool.

12.7 Record the data.[3]

12.7.1 The scale has 1-mm increments grouped in sections of 5 mm each totaling ±20 mm from Line CD).

12.8 If the specimen is between 500 and 800 mm wide, move the Bow and Skew Measurement Tool to the right so that point C is now located where point D was previously (Line CD is 400 mm which is the dimension that the Bow and Skew is to be measured over).

12.9 Position the Bow and Skew Measurement Tool on the cut specimen so that line AB follows the new warp line. The warp line may curve away from Line AB – match points A & B to the warp line (reference Fig. 2).

12.10 Repeat steps 12.8 and 12.9 as needed.

12.11 Repeat steps 12.5 through 12.7.

12.12 If height of the specimen is considerable enough to require multiple measurements, determine a new fill line and repeat steps 12.2 through 12.9.

13. Attribute Data Inspection Method

13.1 The Bow and Skew Measurement Tool (Fig. 1) is designed to incorporate two open slots. Line CD is centered lengthwise in the slots. These slots can be either 20 mm (for face material only application) or 26 mm (for laminated application) wide. One intent of the open slot was to eliminate glare or poor visibility from tool scratching so that the operator could easily follow the pattern or fill line across to the integrated scale.

13.2 The open slot can also be used in the acquisition of Attribute Data if appropriate to customer requirements. The Bow and Skew Measurement Tool would be oriented as in Sections11 and 12 but the operator would only verify if the fill line or pattern stays within the open slot width over the 400 mm length of the measurement area. If the fill line or pattern stays inside, it would be considered acceptable. If the fill line or pattern goes outside the open slot width, it would be rejected based on the appropriate specification.

14. Calculation or Interpretation of Results

14.1 There are no calculations required.

14.2 Interpretation is between contractual parties.

15. Report

15.1 Report the following information:

15.1.1 Skew in mm.

15.1.2 Bow in mm.

15.1.3 The standard conditions on which the testing was performed.

16. Precision and Bias

16.1 The precision of this test method is based on an interlaboratory study of D7811, New Test Method for Standard Test Method for Bow and Skew over a Specified Distance using a Measuring Tool, conducted in 2010. Each of six laboratories was asked to report the skew of six different fabrics. Each of the averages shown in Table 1 is the mathematical average of 24 test results on the same fabric sample by the 6 laboratories (4 results on each fabric sample from each of the 6 participating laboratories). Practice E691 was followed

TABLE 1 Skew (mm)

Fabric	Average[A] $\bar{x}$	Repeatability Standard Deviation s_r	Reproducibility Standard Deviation s_R	Repeatability Limit r	Reproducibility Limit R
Sample A	4.15	2.52	2.52	7.0	7.0
Sample B	10.67	6.23	6.23	17.4	17.4
Sample C	12.00	6.26	6.26	17.5	17.5
Sample D	3.27	1.76	1.76	4.9	4.9
Sample E	7.58	4.46	4.63	12.5	13.0
Sample F	5.67	3.07	3.07	8.6	8.6

[A] Each of the averages shown is the mathematical average of the 24 test results on the same fabric sample by the 6 laboratories (4 results from each of the 6 participating laboratories).

for the design and analysis of the data; the details are given in an ASTM Research Report[4]

16.1.1 *Repeatability limit (r)*—Two test results obtained within one laboratory shall be judged not equivalent if they differ by more than the "*r*" value for that material; "*r*" is the interval representing the critical difference between two test results for the same material, obtained by the same operator using the same equipment on the same day in the same laboratory.

16.1.1.1 Repeatability limits are listed in Table 1.

16.1.2 *Reproducibility limit (R)*—Two test results shall be judged not equivalent if they differ by more than the "*R*" value for that material; "*R*" is the interval representing the critical difference between two test results for the same material, obtained by different operators using different equipment in different laboratories.

16.1.2.1 Reproducibility limits are listed in Table 1.

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

16.1.4 Any judgment in accordance with statements 16.1.1 and 16.1.2 would have an approximate 95 % probability of being correct.

16.2 *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.

16.3 Following the exclusion of identified outlier data, this precision statement was determined through the statistical examination of 144 test results, from six laboratories, on six fabrics which were described as:

Sample A	flame laminated knitted seating fabric
Sample B	unlaminated knitted seating fabric
Sample C	unlaminated knitted seating fabric
Sample D	laminated knitted seating fabric
Sample E	laminated knitted seating fabric
Sample F	laminated knitted seating fabric

16.4 If using the data shown in Table 1, select a fabric type that is closest in characteristics to the material being tested.

17. Keywords

17.1 bow; fabric; knitted fabric; measuring tool; skew; woven fabric

[4] Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:D13-1137. Contact ASTM Customer Service at service@astm.org.