



## Standard Test Method for Tuft Bind of Pile Yarn Floor Coverings<sup>1</sup>

This standard is issued under the fixed designation D 1335; 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 reappraisal. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reappraisal.

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

### 1. Scope

1.1 This test method covers the measurement of the force required to pull a tuft completely out of a pile yarn floor covering sample.

1.2 This test method is applicable to both cut and loop pile yarn floor covering.

1.3 The values stated in SI units are to be regarded as standard; the values in inch-pound units are provided as information only and are not exact equivalents. In case of referee decisions the SI units shall prevail.

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 76 Specification for Tensile Testing Machines for Textiles<sup>2</sup>
- D 123 Terminology Relating to Textiles<sup>2</sup>
- D 1776 Practice for Conditioning Textiles for Testing<sup>2</sup>
- D 2904 Practice for Interlaboratory Testing of a Textile Test Method that Produces Normally Distributed Data
- D 2906 Practice for Statements on Precision and Bias for Textiles
- D 5684 Terminology Relating to Pile Floor Coverings<sup>3</sup>

### 3. Terminology

#### 3.1 Definitions:

3.1.1 *cut pile yarn floor covering, n*—a pile yarn floor covering in which the pile is composed of adjacent tuft elements which are separated or cut.

3.1.2 *loop pile yarn floor covering, n*—a pile yarn floor covering in which the pile is composed only of uncut loops.

3.1.3 *tuft bind, n*—*in pile fabrics*, the force required to pull a tuft element from the pile yarn floor covering.

<sup>1</sup> This test method is under the jurisdiction of ASTM Committee D-13 on Textiles and is the direct responsibility of Subcommittee D13.21 on Pile Floor Covering.

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<sup>2</sup> *Annual Book of ASTM Standards*, Vol 07.01.

<sup>3</sup> *Annual Book of ASTM Standards*, Vol 07.02.

3.1.4 For definitions of pile yarn floor covering related terms, refer to Terminology D 5684. For definitions of other textile terms used in this test method refer to Terminology D 123.

### 4. Summary of Method

4.1 A specimen (tuft leg or loop) is mounted in a special clamping fixture of a tensile testing machine and the test sample containing the specimen is mounted on a special holder on the tensile testing machine. The force to pull the specimen free from the test sample is measured as the tuft bind.

### 5. Significance and Use

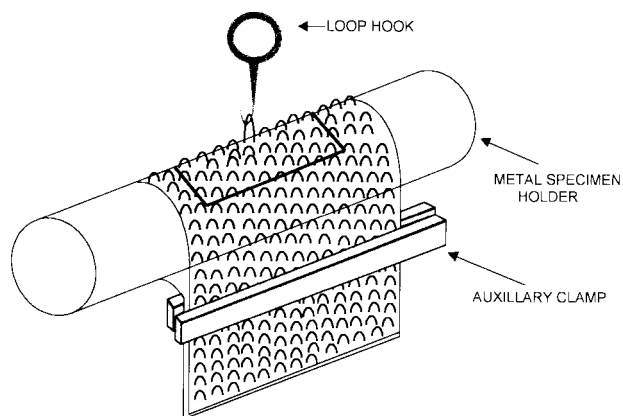
5.1 Test Method D 1335 for tuft bind of pile yarn floor coverings is being used for acceptance testing of commercial shipments. Comparative tests as directed in 5.1.1 may be advisable.

5.1.1 In case of a dispute arising from differences in reported test results using this test method, 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 from the investigation of bias. As a minimum, the two parties should take a group of test samples that are homogeneous as possible and are from a lot of material of the type in question. The test samples should then be randomly assigned in equal numbers to each laboratory for testing. The average results from the two laboratories should be compared using appropriate statistical analysis, and a probability level chosen by the two parties before testing 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.

5.2 The satisfactory performance of a pile yarn floor covering depends to a considerable extent on the maintenance of its original appearance. In a cut pile yarn floor covering an inadequate tuft bind may result in complete loss of pile in areas exposed to severe wear. In a looped pile yarn floor covering with inadequate tuft bind the pile loops may be pulled out to form unsightly long loops which may be hazardous.

### 6. Apparatus

6.1 *Tensile Testing Machine*, Constant-rate-of-extension (CRE) type, conforming to Specification D 76, with a capacity selected such that the force required to complete the test falls



**FIG. 1 Metal Specimen Holder, Cut-Away Type**

within 15 to 85 % of full scale. A full scale ranging from 4.45 N to 111 N (1 lbf to 25 lbf) is generally adequate. For constant-rate-of-extension (CRE) type and constant-rate-of-traverse (CRT) type machines, the rate is  $300 \pm 10$  mm/min ( $12 \pm 0.5$  in./min). In case of controversy the CRE type tensile testing machine shall prevail.

NOTE 1—The test results obtained with different types of testing machines is not always the same.

6.2 *Metal Cylindrical Sample Holder*, 150 mm (6.0 in.) long made from 40 mm (1.5 in.) outside diameter tubing with a section 50 mm (2.0 in.) long portion of the tubing cut away. See Fig. 1. The sample holder should be constructed in a manner that will permit clamping the test sample in the nonmeasuring, pulling clamp of the tensile testing machine or replacement of the nonmeasuring clamp by the sample holder.

6.3 *Tuft Clamp*, for use only with cut pile, consisting of tweezer-like clamp that can be used to grip a single tuft tightly enough to assure removal of the whole tuft from the pile yarn floor covering without slippage of the tuft in the tuft clamp. Alternatively, a hemostat<sup>4</sup> can be used.

6.4 *Loop Hook*, for use only with loop pile, consisting of a hook which can be readily passed through the loop and hooked under the top of the loop. The hook should be made of wire having a diameter of at least 0.8 mm ( $1/32$  in.) and should be constructed so that it can be clamped/attached to, or replace, the measuring clamp of the test machine.

## 7. Sampling

7.1 *Lot Sample*—As a lot sample for acceptance testing, take at random the number of rolls, or pieces, of pile yarn floor covering as directed in an applicable material specification or other agreement between the purchaser and the supplier. Consider the rolls, or pieces, of pile yarn floor covering to be the primary sampling units. In the absence of such agreement, take one roll or piece from the lot to be tested.

NOTE 2—An adequate specification or other agreement between the purchaser and supplier requires taking into account the variability between rolls or pieces of pile yarn floor covering and between specimens from a roll or pieces of pile yarn floor covering to provide a sampling plan with

<sup>4</sup> Three Hemostats suitable for this purpose can be obtained from many laboratory equipment suppliers.

a meaningful producer's risk, consumer's risk, acceptable quality level, and limiting quality level.

7.2 *Laboratory Sample*—For acceptance testing, take a 1 m (1 yd) section extending the width of the pile yarn floor covering and at least 150 mm (6 in.) along the machine direction from each roll, or piece, in the lot. For rolls of pile yarn floor covering, take a sample that will exclude fabric from the outer wrap of the roll or the inner wrap around the core.

7.3 *Test Sample*—From each laboratory sampling unit, cut five test samples with the longer direction parallel to the machine direction. Consider the long direction as the direction of test. Cut each test sample 150 mm  $\times$  200 mm (6 in.  $\times$  8 in.). The test sample should be taken no nearer to the edge than 5 % of the pile yarn floor covering width.

7.3.1 If the pile floor covering is back coated only, exercise care in handling the sample to prevent breaking, or otherwise disturbing, the back coating.

7.4 *Test Specimens*—Test three specimens from each test sample. A specimen is a tuft leg or loop. In cases where a pile yarn floor covering contains both cut and uncut pile, test only the uncut (loop).

NOTE 3—If the uncut (loop) is satisfactory, the cut pile will be adequate.

7.5 *Test Result*—The test result is the average for the three specimens in a test sample.

## 8. Preparation and Verification of Apparatus

8.1 *Tensile Testing Machine*, A constant-rate-of-extension (CRE) type conforming to Specification D 76 with a constant rate-of-traverse of  $300 \pm 10$  mm/min ( $12 \pm 0.5$  in./min) is preferred. A constant-rate-of-traverse (CRT) type tensile testing machine conforming to Specification D 76 and operated at the same speed is permitted.

8.2 If required, replace the nonmeasuring clamp of the test machine with the sample holder described in 6.2.

8.3 Replace the measuring clamp of the test machine with, or attach to the measuring clamp of the test machine, the tuft clamp described in 6.3 or the loop-hook described in 6.4 depending on which is required for the type of pile yarn floor covering under test (Note 3).

8.3.1 Because the tuft clamp or loop hook is attached to, or replaces, the usual measuring clamp of the test machine, compensate for the effect of the altered mass of the clamp to retain the previous verification of the testing machine.

## 9. Conditioning

9.1 Bring the test samples to moisture equilibrium for testing in the standard atmosphere for testing textiles, approaching equilibrium from the dry side, without heat. Determine that moisture equilibrium for testing has been attained as directed in Practice D 1776.

## 10. Procedure

10.1 *Cut Pile Yarn Floor Covering*:

10.1.1 Test the conditioned specimens in the standard atmosphere for testing textiles.

10.1.2 Mount the test sample on the sample holder and place in the stationary clamp jaws with the rows of tufts (machine

direction) at right angles to the long axis of the holder in such a position that the tuft to be tested is approximately centered over the cut away portion of the holder. The tension on the test sample should be uniform across the clamp width so that the sample presents an undistorted cylindrical surface over the cut away section of the sample holder. Locate a tuft to be pulled out directly below the center of the pulling clamp or hook.

10.1.3 Select only one tuft for testing from any one row and allow at least 25 mm (1.0 in.) between any tuft tested and the edge of the sample.

10.1.4 Using the tuft clamp grip one tuft leg (Fig. 2). Make certain that all fibers forming the tuft leg are securely gripped by the tuft clamps. Take care not to pinch, “break the back” or otherwise deform the test sample in the selection of, and attachment of the clamp to, the specimen under test.

10.1.5 Start the testing machine. Record the maximum force to the nearest 0.5 N (0.1 lbf). This is tuft bind.

10.1.6 Test the remaining specimens taking them from different rows.

10.2 *Loop Pile Yarn Floor Covering:*

10.2.1 Test the conditioned specimens in the standard atmosphere for testing textiles.

10.2.2 Mount the test sample on the sample holder as described in 10.1.2.

10.2.3 Select only one loop for testing from any one row of tufts and allow at least 25 mm (1.0 in.) between any loop tested and the edge of the test sample. Insert the loop hook in the loop to be tested. See Fig. 3.

NOTE 4—If Section 10 is not followed, a spurious value may be obtained if one or both ends of the loop under test is buried in the back construction for a number of construction repeats.

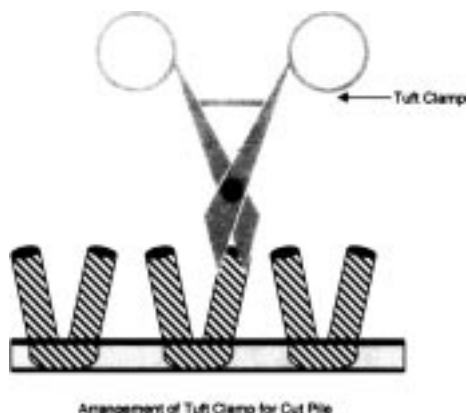
10.2.4 Start the testing machine. Record the maximum force to the nearest 0.5 N (1.0 lbf). This is tuft bind.

10.2.5 Test the remaining specimens taking them from different rows.

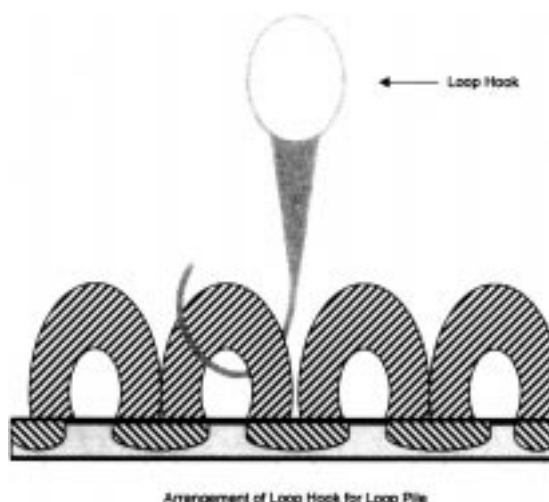
**11. Calculation**

11.1 Calculate the average tuft bind to the nearest 0.5 N (1.0 lbf) for each test sample, each laboratory sampling unit, and the lot.

11.1.1 Recent innovations in tufting machines have included equipment with dual needle bars which traverse later-



**FIG. 2 Arrangement of Tuft Clamp, And Tufts for Testing**



**FIG. 3 Arrangement of Hook, And Loops for Testing**

ally as the backing moves through the tufting machine. This can result in stitches which cross over other stitches on the back side of the material. The stitches in the plane which are closest to the primary backing, and those which cross over other stitches create a bimodal distribution of numbers which should not be used to calculate an “average” value without including the range.

**12. Report**

12.1 State that the tests were performed as directed in the Test Method D 1335. Describe the product sampled and the method of sampling.

12.2 Report the following information:

12.2.1 The tuft bind for each test sample, laboratory sample, and the lot sample.

12.2.2 The number of specimens tested, and samples tested.

12.2.3 The type of tensile testing machine used for the test.

**13. Precision and Bias**

13.1 *Summary*—In comparing two averages, the differences should not exceed the single-operator precision values shown in Tables 1 and 2 for the respective number of tests in 95 out of 100 cases when all the observations are taken by the same well trained operator using the same test method techniques and specimens randomly drawn from the sample of material. Larger differences are likely to occur under all other circumstances.

13.2 *Interlaboratory Test Data*—An interlaboratory test was run in 1997 in which randomly-drawn samples of four materials were tested in each of two laboratories. Each laboratory

**TABLE 1 Critical Differences for Two Averages for the Conditions Noted 95 % Probability Level, lbs**

Number of Test Results in Each Average	Single Material Comparisons		Between-Laboratory Precision
	Single Operator Precision	Within-Laboratory Precision	
1	1.13	1.13	1.13
5	.50	.52	.52
10	.36	.38	.38
15	.29	.32	.32

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**TABLE 2 Critical Differences for Two Averages for the Conditions Noted 95 % Probability Level, lbs**

Number of Test Results in Each Average	Multi-material Comparisons		Between-Laboratory Precision
	Single Operator Precision	Within-Laboratory Precision	
1	1.13	1.13	1.58
5	.50	.52	1.21
10	.36	.38	1.16
15	.29	.32	1.14

used two operators, each of whom tested 2 specimens of each material using Test Method D 1335. The components of variance for tuft bind expressed as standard deviations were calculated to be the values listed in Table 3. Analysis of the data was conducted using Practice D 2904, Practice D 2906 and the Adjunct “Tex-Pac”. The material types were:

- Material 1: Tufted/shifted commercial cut pile
- Material 2: Tufted/shifted commercial cut pile
- Material 3: Tufted/shifted commercial loop pile
- Material 4: Tufted/shifted commercial loop pile

13.3 *Precision*—For the components of variance reported in Table 3, two averages of observed values should be considered significantly different at the 95 % probability level if the difference equals or exceeds the critical differences listed in Tables 1 and 2.

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**TABLE 3 Components of Variance Expressed as Standard Deviations<sup>A</sup>**

Variance Component	Single Material Comparisons	Multi-material Comparisons
Single Operator	.41	.41 + 0
Within Laboratory	.05	0
Between Laboratory	0	.40

<sup>A</sup> The square roots of the components of variance are being reported to express the variability in the appropriate units of measure rather than as the squares of those units of measure.

NOTE 5—The tabulated values of the critical differences should be considered to be a general statement, particularly with respect to between-laboratory precision.

NOTE 6—Because the interlaboratory test included less than five laboratories, estimates of between-laboratory precision may be either underestimated or overestimated to a considerable extent and should be used with special caution.

13.4 *Bias*—The value of tuft bind of pile floor coverings can only be defined in terms of a test method. Within this limitation, Test Method D 1335 has no known bias.

**14. Keywords**

- 14.1 carpet; floor-covering; pile yarn; tuft bind