Designation: D1335 – 17

Standard Test Method for Tuft Bind of Pile Yarn Floor Coverings[1]

This standard is issued under the fixed designation D1335; 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 force required to pull or break a tuft from a pile 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 inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that 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 and health 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]

D76 Specification for Tensile Testing Machines for Textiles
D123 Terminology Relating to Textiles
D1776 Practice for Conditioning and Testing Textiles
D5684 Terminology Relating to Pile Floor Coverings
E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method
E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods

3. Terminology

3.1 For all terminology related to Pile Floor Coverings, D13.21, refer to Terminology D5684.

3.1.1 The following terms are relevant to this standard: carpet, constant-rate-of-extension, cut pile yarn floor covering, finished, finished pile yarn floor covering, floor covering, loop pile yarn floor covering, pile, pile yarn floor covering, textile floor covering, tuft, tuft bind, tuft leg, tufted fabric.

3.2 For all other terminology related to textiles see Terminology D123.

4. Summary of Method

4.1 A test sample is mounted in a special clamping fixture to the base of a tensile testing machine. A hook (for loops specimen) or a tuft clamp (for cut pile specimen) are used to remove a specimen from the sample. 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 D1335 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

[1] This test method is under the jurisdiction of ASTM Committee D13 on Textiles and is the direct responsibility of Subcommittee D13.21 on Pile Floor Coverings.

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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.

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 D76, with a capacity selected such that the force required to complete the test falls within 15 to 85 % of full scale. A full scale ranging from 1 to 25 lbf (4.45 to 111 N) is generally adequate. For constant-rate-of-extension (CRE) type and constant-rate-of-traverse (CRT) type machines, the rate is 12 ± 0.5 in./min (300 ± 12 mm/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 *Clamps and Jaw Faces*—The use of hydraulic or pneumatic clamping systems with a minimum of 1 by 3 in. (25 by 76 mm) serrated or padded faces designed to minimize slippage in the clamps during testing is recommended. Manual clamping is permitted providing no slippage of the specimen is observed. The faces shall be parallel and have matching centers with respect to one another in the same clamp and to the corresponding jaw face of the other clamp.

6.3 *Metal Cylindrical Sample Holder,* 6.0 ± 0.5 in. (152 ± 12 mm) long made from 1.5 ± 0.06 in. (38 ± 1.5 mm) outside diameter tubing with a section 2.0 ± 0.2 in. (50 ± 5.0 mm) long and 1.5 ± 0.2 in. (38 ± 5 mm) wide cut away from the center portion of the tubing. See Fig. 1 and Fig. 2. The sample holder should be constructed in a manner that will permit clamping the test sample in the non-measuring clamp of the tensile testing machine or replacement of the non-measuring clamp by the sample holder.

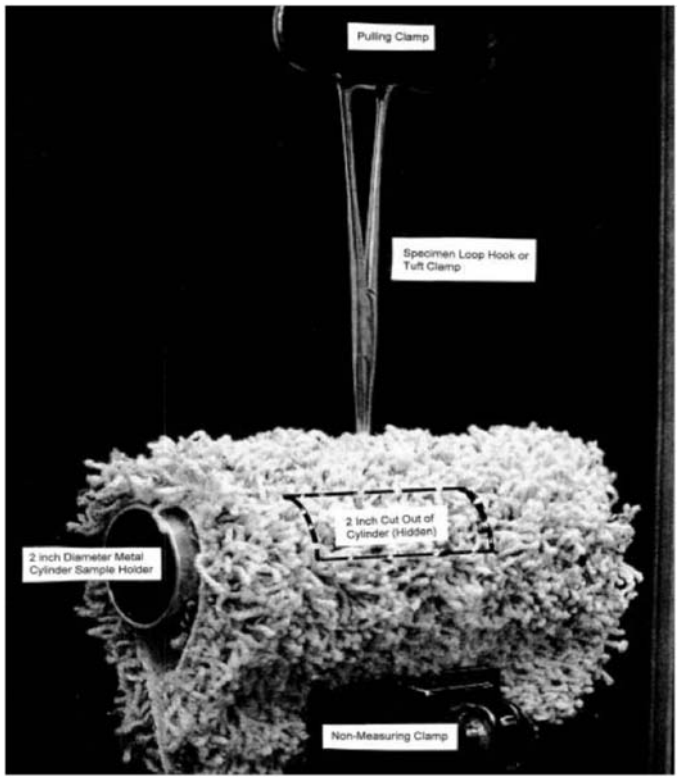

FIG. 1 Relative Position of Cylinder Opening, Cylinder, the Cylinder, Hook or Tuft Clamp and the Carpet Sample

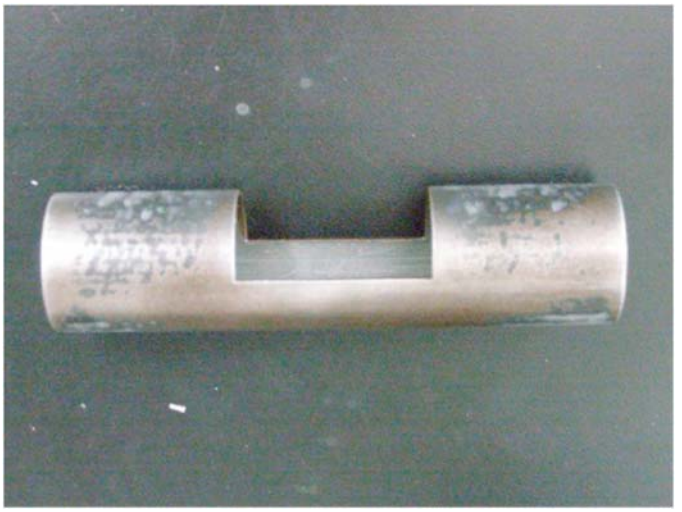

FIG. 2 Cylinder Configuration

6.4 *Tuft Clamp,* for use with a cut pile specimen. The clamp is a tweezer-like device that can be used to grip a single tuft tightly enough to ensure removal from the sample without slippage. The gripping of the tuft by the tuft clamp is shown in Fig. 3. Alternatively, a hemostat[3] can be used.

6.5 *Loop Hook,* for use with loop pile specimen. The hook should be designed to readily pass through a tufted loop. The hook should be made of steel wire having a diameter of at least 1/32 in. (0.8 mm). The wire must be constructed so that it can be hooked into the test specimen and then clamped/attached to, or replace, the measuring clamp of the test machine. (See Fig. 4).

[3] Hemostats suitable for this purpose can be obtained from many laboratory equipment suppliers.

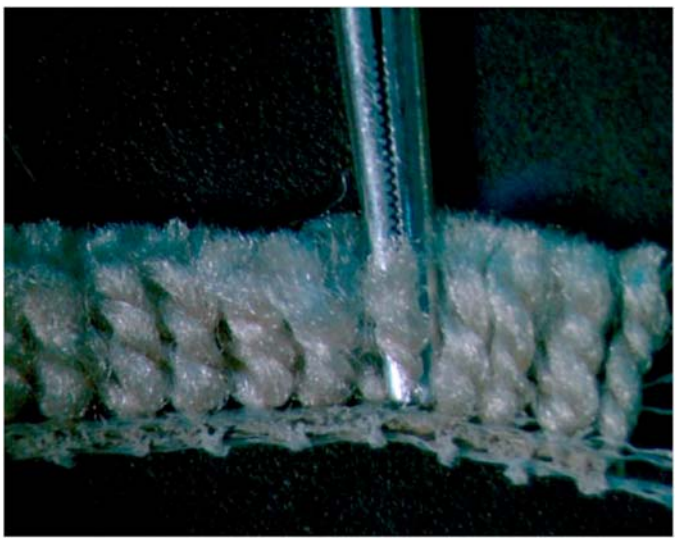

FIG. 3 Tuft Clamp Device Gripping Tuft Leg

FIG. 4 Loop Hook Secured in the Upper Clamp (Note the hook has been passed through the loop)

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

7.2 *Laboratory Sample*—For acceptance testing, cut a section extending the full width of the pile yarn floor covering and at least 4 in. (100 mm) longer than the test sample requested in 7.3, from each roll, or piece, in the lot. For rolls of pile floor covering, take a sample that will exclude fabric with visible damage.

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 6 by 8 in. (150 by 200 mm). 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 D76 with a constant rate-of-traverse of 12 ± 0.5 in./min (300 ± 10 mm/min) is preferred. A constant-rate-of-traverse (CRT) type tensile testing machine conforming to Specification D76 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 6.3.

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 6.4 or the loop-hook described in 6.5 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 Condition the specimen in the standard atmosphere for testing textiles in accordance with Practice D1776.

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 or loop to be pulled out directly below the center of the pulling clamp or hook (see Fig. 1).

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

10.1.4 Using the tuft clamp grip one tuft leg (Fig. 3). Make certain that all fibers forming the tuft leg are securely gripped by the tuft clamp. If multiple, single yarn ends form a leg,

combine all the yarn ends, and test as one end. 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 remove the tuft to the nearest 0.1 lbf (0.5 N). This force is called a tuft bind.

10.1.6 If the specimen breaks before it pulls away from the pile floor covering, evaluate the tuft and determine if the break was: *(a)* away from the jaw of the clamp, or *(b)* at the jaws of the clamp. If the break is away from the jaws of the clamp, consider the tuft bind strength of the specimen greater than the strength of the yarn and record the value. Note that the specimens tuft bind exceeded the strength for the yarn. Conversely, if the break is at the jaws of the clamp, discard the result because the clamping of the specimen damaged the tuft leg. Note that the specimen was discarded because of clamping damage to the specimen.

10.1.7 Test the remaining specimens taking them from different tuft rows at least 1 in. (25 mm) away from the first specimen.

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 1 in. (25 mm) between any loop tested and the edge of the test sample. Insert the loop hook in the loop to be tested. See Fig. 4.

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

10.2.4 Start the testing machine. Record the maximum force to remove the loop specimen from the sample to the nearest 0.1 lbf (0.5 N). This value is called tuft bind. If the yarn breaks before the tuft is removed from the sample, record the result and note that the tuft blind strength exceeded the yarn strength.

10.2.5 Test the remaining specimens taking them from a different tuft row.

11. Calculation

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

11.1.1 Tufting machines can produce 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 an expression of the average's variation (that is, the population range or standard deviation).

12. Report

12.1 State that the tests were performed as directed in the Test Method D1335. 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.

12.2.4 Any specimen that broke before being removed from the backing.

12.2.5 Any specimens that were discarded.

13. Precision and Bias

13.1 The precision of this test method is based on an interlaboratory study of ASTM D1335, Standard Test Method for Tuft Bind of Pile Yarn Floor Coverings, conducted in 2010. Five laboratories participated in this study, testing five samples of two carpet types. Every "test result" represents the average of 15 individual determinations. Each laboratory reported three replicate test results for each material. Practice E691 was followed for the analysis of the data; the details are given in an ASTM Research Report.[4]

13.1.1 *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.

13.1.1.1 Average repeatability limits are listed in Table 1.

13.1.2 *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.

13.1.2.1 Average reproducibility limits are listed in Table 1.

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

13.1.4 Any judgment in accordance with statement 13.1.1 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 laboratories reporting replicate 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

[4] Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:D13-1134.

TABLE 1 Tuft Bind (N)

Material	Average[A]	Repeatability Standard Deviation	Reproducibility Standard Deviation	Repeatability Limit	Reproducibility Limit
	$\bar{x}$	s_r	s_R	r	R
Cut Pile	4.1	0.6	0.7	1.6	2.0
Loop	9.0	0.6	1.0	1.6	2.7

[A] The average for all laboratories, across all pile yarn floor covering materials tested.

TABLE 2 Cut Pile (N)

Material	Average[A]	Standard Deviation	s_r	s_R	r	R
Sample 1	3.220	0.791	0.399	0.856	1.118	2.396
Sample 2	3.573	0.555	0.634	0.759	1.774	2.124
Sample 3	4.493	0.478	0.639	0.708	1.790	1.982
Sample 4	4.187	0.328	0.584	0.584	1.634	1.634
Sample 5	4.800	0.211	0.623	0.623	1.746	1.746

[A] The average for all laboratories, across all pile yarn floor covering materials tested.

TABLE 3 Loop (N)

Material	Average[A]	Standard Deviation	s_r	s_R	r	R
Sample 1	12.133	0.617	0.904	0.962	2.530	2.693
Sample 2	7.867	0.983	0.509	1.067	1.426	2.989
Sample 3	6.360	0.649	0.509	0.770	1.424	2.157
Sample 4	7.977	0.852	0.259	0.878	0.725	2.459
Sample 5	10.647	1.085	0.710	1.230	1.988	3.443

[A] The average for all laboratories, across all pile yarn floor covering materials tested.

would imply. Consider the repeatability limit as a general guide, and the associated probability of 95 % as only a rough indicator of what can be expected.

13.2 *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.

13.3 The precision statement was determined through statistical examination of 149 results, from 5 laboratories, analyzing Cut Pile and Loop samples of the five materials described below.

Cut Pile Products:	
Sample 1	White Frieze High Pile Height
Sample 2	Beige Frieze Medium Pile Height
Sample 3	Green Low Pile Height
Sample 4	Beige Dense Medium Pile Height
Sample 5	Beige Low Pile Height
Loop Products:	
Sample 1	Berber Loop Unitary Back
Sample 2	Green. Brown, and White Level Loop Tile
Sample 3	Golden Brown, Ribbed Loop Tile
Sample 4	Multiple Colored Sections Level Loop Tile
Sample 5	White Level Loop Action Bac

14. Keywords

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