



Designation: D4685/D4685M – 15 (Reapproved 2020)

## Standard Test Method for Pile Fabric Abrasion<sup>1</sup>

This standard is issued under the fixed designation D4685/D4685M; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

### 1. Scope

1.1 This test method covers the determination of the abrasion of pile fabrics when the loss of pile tufts occur, sometimes called pile retention or pile pull out. It includes two procedures:

1.1.1 *Procedure A*—The “Heavy Duty” procedure describes the test option for fabrics over 240 g/m<sup>2</sup> (7 oz/yd<sup>2</sup>) or fabrics which should meet heavy duty end-use conditions of wear.

1.1.2 *Procedure B*—The “Light Duty” procedure describes the test option for fabrics under 240 g/m<sup>2</sup> (7 oz/yd<sup>2</sup>) or fabrics which should meet light duty end-use conditions of wear.

1.2 The test method is intended for both regular, ribless woven corduroy or other woven pile fabric constructions.

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 are not necessarily exact equivalents; therefore, to ensure conformance with the standard, each system shall be used independently of the other, and values from the two systems shall not be combined.

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:*<sup>2</sup>

**D123** Terminology Relating to Textiles

**D1776** Practice for Conditioning and Testing Textiles

**D2724** Test Method for Bond Strength of Bonded, Fused, and Laminated Apparel Fabrics

**D3884** Guide for Abrasion Resistance of Textile Fabrics (Rotary Platform, Double-Head Method)

**D4850** Terminology Relating to Fabrics and Fabric Test Methods

**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 *ASTM Adjunct:*<sup>3</sup>

Photographic Scale for Pile Retention

2.3 *AATCC Method:*<sup>4</sup>

**TM 135** Dimensional Changes of Fabrics after Home Laundering

### 3. Terminology

3.1 For all terminology related to D13.59 on Fabric Test Methods, General, see Terminology **D4850**.

3.2 The following terms are relevant to this standard: abrasion, corduroy, pile fabric, pile retention, velveteen.

3.3 For definitions of all other textile terms see Terminology **D123**.

### 4. Summary of Test Method

4.1 Test specimens are exposed to a specified number of abrasion cycles on face and back separately and then evaluated by viewing the specimen over a light box and comparing to photographic standards. The method measures only the amount of pile pulled out of the base fabric structure and not the surface pile appearance attributes, such as crushed or flatten ribs.

### 5. Significance and Use

5.1 This test method is considered satisfactory for quality control testing and commercial shipment acceptance.

<sup>1</sup> This test method is under the jurisdiction of ASTM Committee **D13** on Textiles and is the direct responsibility of Subcommittee **D13.59** on Fabric Test Methods, General.

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<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

<sup>3</sup> A set of six photographic standards for pile retention of corduroy fabrics is available from ASTM International Headquarters. Order Adjunct No. **ADJ4685**.

<sup>4</sup> Available from American Association of Textile Chemists and Colorists (AATCC), P.O. Box 12215, Research Triangle Park, NC 27709, <http://www.aatcc.org>.



5.1.1 In case of a dispute arising from differences in reported test results when 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 for the investigation of bias. As a minimum, the two parties should take test specimens that are from the lot of material of the type in question. The 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 student's t-test for unpaired data and an acceptable probability level chosen by the two parties before the 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 in the light of the known bias.

5.2 Finishes and changes in fabric surfaces may exert a large effect on pile retention of corduroy. Therefore, it may be desirable to test before as well as after laundering or drycleaning, or both.

5.3 The separate testing of specimens on the face and back of the fabric is important in this test method since the pile pull-out may be due to abrasive action on either the face or back. With many pile fabrics, specifically corduroy constructions, pile retention properties are worse when abraded on the back.

## 6. Apparatus

6.1 *Rotary Platform Abraser*, as described in Test Method **D3884** and consisting of the following:

6.1.1 *Specimen Holder*, rubber pad, clamp plate, and clamp ring.

6.1.2 *Auxillary Weight*, to give a load of 500 g per wheel (exclusive of the mass of the wheel).

6.1.3 *Vacuum Unit*.

6.2 *CS-10 Calibrase Abrading Wheels*<sup>5</sup>.

6.2.1 The wheels shall be a cylindrical shape which includes an axial hole  $16.0 \pm 0.1$  mm ( $0.625 \pm 0.004$  in.); sides of the wheel shall be parallel, and each wheel shall be  $12.7 \pm 0.3$  mm ( $0.50 \pm 0.012$  in.) thick and have an external diameter of less than 52 mm (2 in.) when new but in no case less than 44.4 mm (1.75 in.).

6.3 *Resurfacing Discs (S-11)*, used to resurface the CS-10 abrading wheels.

6.3.1 The resurfacing disc shall be 150 grit silicon carbide coated abrasive paper, approximately 102 mm (4 in.) diameter with a 7 mm ( $\frac{1}{4}$  in.) center hole.

6.4 *Round Template*, or die approximately 135 mm ( $5\frac{1}{4}$  in.) in diameter for cutting out specimens.

6.5 *Photographic Rating Standards*.<sup>3</sup>

6.6 *Lighted Viewing Box*, for evaluation (see **Fig. 1**).

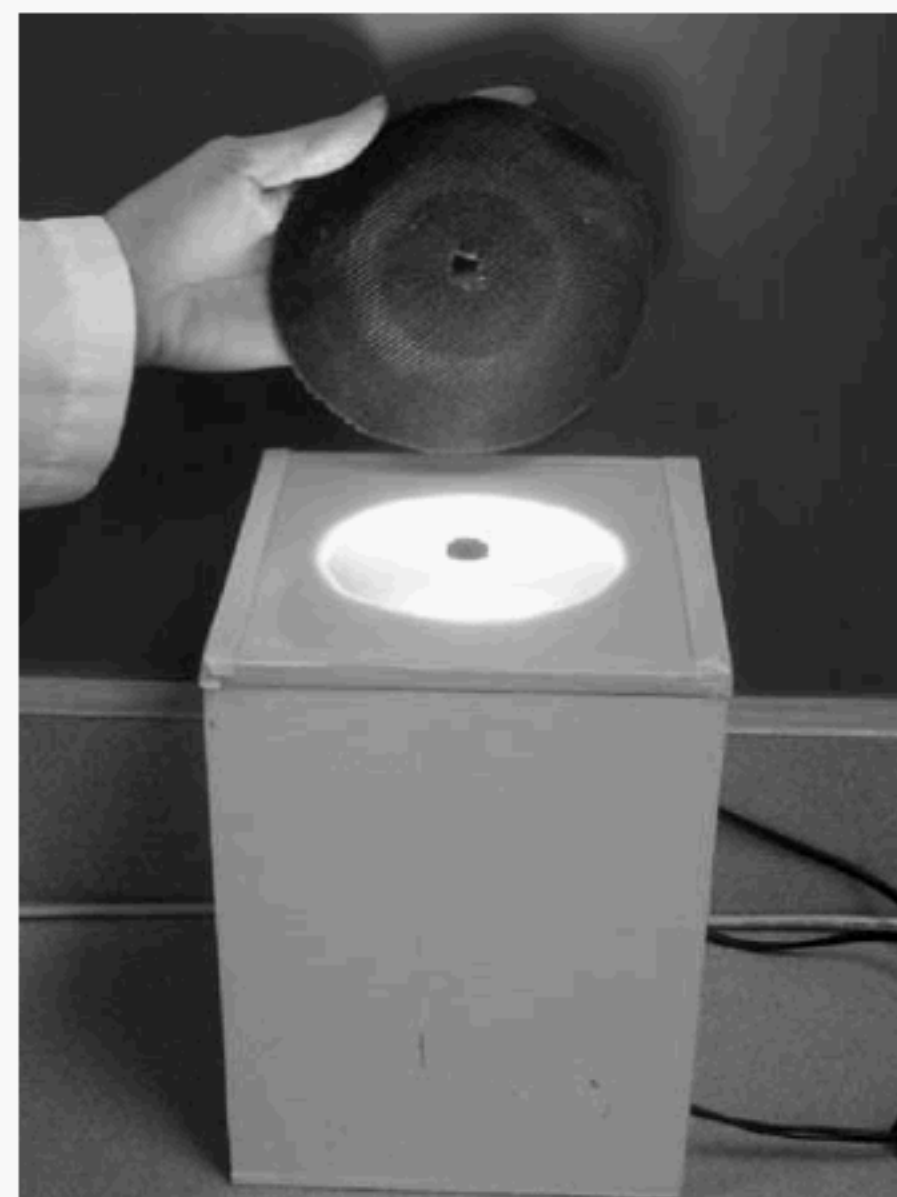


FIG. 1 Pile Retention Viewing Box

6.6.1 The box is approximately 215 mm ( $8\frac{3}{8}$  in.) in height, 150 mm ( $5\frac{7}{8}$  in.) wide, 150 mm ( $5\frac{7}{8}$  in.) in depth, with a 90 mm ( $3\frac{3}{4}$  in.) diameter opening in the top. The opening is covered with a clear glass plate which has a black 25 mm (1 in.) circular tape glued to the center of the opening to prevent light from passing through the center hole of the specimen while grading.

6.6.2 The box contains a 75 W reflector flood light<sup>6</sup> the top of which is 38 mm ( $1\frac{1}{2}$  in.) below the glass surface of the box and the specimen. The lamp size and spacing is critical.

## 7. Sampling

7.1 *Lot Sample*—As a lot sample for acceptance testing, take at random the number of rolls of fabric directed in an applicable material specification or other agreement between the purchaser and the supplier. Consider rolls of fabric to be the primary sampling units.

7.2 *Laboratory Sample*—As a laboratory sample, take from each roll of fabric in the lot sample a full width swatch at least 500 mm (20 in.) long after removing at least 1 m (1 yd) of fabric from the outside of the roll. If the fabric is also to be evaluated after laundering or drycleaning, take a second full width swatch 500 mm (20 in.) long from each roll of fabric in the lot sample.

7.3 *Test Specimens*—Cut four specimens from each swatch in the laboratory sample as directed in **8.1**.

## 8. Specimens and Preparation

8.1 Using the template or die specified in **6.4**, cut four specimens approximately 135 mm ( $5\frac{1}{4}$  in.) in diameter from each laboratory sample. If a sample is to be evaluated after laundering or drycleaning, four additional specimens will be taken. (See Section 9).

<sup>5</sup> The sole source of supply of the apparatus known to the committee at this time is Taber Industries, North Tonawanda, NY. If you are aware of alternative suppliers, please provide this information to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee,<sup>5</sup> which you may attend.

<sup>6</sup> A 75-watt reflector flood light manufactured by General Electric Co. (75R 30/FL) has been found suitable for this purpose.



8.2 Cut the specimens from each laboratory sample so that each specimen contains different warp and filling yarns. Two specimens are to be used to test the face of the sample and two specimens to test the back of the fabric.

8.3 Prepare specimen by folding the round specimen twice and cutting off the pointed tip to produce a 6-mm (1/4-in.) hole in the center of the specimen to accommodate the clamping screw.

8.4 Determine the fabric mass or identify the anticipated end-use of the sample, or both, for proper selection of the testing option.

8.5 Prior to testing, ensure the expiration date of the abrasion wheels has not passed for the CS-10 wheels. Follow the manufacturer's recommended procedure for breaking in new, or resurfacing and cleaning wheel sets.

NOTE 1—See detailed instructions on preconditioning and other operations in the instrument manual or those in Test Method [D3884](#).

## 9. Laundering and Drycleaning

9.1 *Laundering*—If the fabric is to be evaluated after laundering, launder the appropriate laboratory samples for three cycles using AATCC TM 135, unless the purchaser and supplier agree to use an alternate procedure.

9.2 *Drycleaning*—If the fabric is to be evaluated after drycleaning, dryclean the appropriate laboratory samples for three cycles as directed in Method [D2724](#), unless an alternative procedure is agreed upon by the purchaser and supplier.

## 10. Conditioning

10.1 Bring the specimens to moisture equilibrium without preconditioning, as directed in Practice [D1776](#).

## 11. Standardization

11.1 To ensure that the abrading function of the wheels is maintained at a constant level, prepare the abrading wheels prior to each test.

11.2 Mount the resurfacing disc on the specimen holder and secure in place with the clamp plate, nut and clamping ring. Use the same load that will be used for testing (see [12.6.1](#) or [12.6.2](#)). Lower the abrading heads carefully until the wheels rest squarely on the abrasive disc. Set the vacuum suction force to 100. Place the vacuum pick-up nozzle in position and adjust it to approximately 6.35 mm (1/4 in.) above the resurfacing disc.

11.3 Resurface the wheels by running them 25 cycles against the resurfacing medium. Each S-11 resurfacing disk is good for one resurfacing operation, after which it shall be discarded.

## 12. Procedure

12.1 Test the conditioned specimens in the standard atmosphere for testing textiles. See Practice [D1776](#).

12.2 Mount the specimen on the holder and attach the clamp plate and nut.

12.2.1 Position the clamp ring to a tight fit over the specimen and holder and draw the specimen taut by pressing the hold down ring uniformly over the edge of the holder.

When the desired tension is obtained, tighten the clamp ring screw. Avoid excessive tightening of the clamp ring screw so as to prevent specimen wrinkling. (Fabrics with stretch yarns are difficult to mount uniformly.)

12.2.2 If the specimen holder is removed to mount or analyze specimens, ensure the holder is properly replaced on the drive shaft of the tester.

12.3 Lower the abrading heads carefully onto the surface of the specimen.

12.4 Lower the vacuum suction nozzle and adjust it to approximately 6.35 mm (1/4 in.) above the specimen. Failure to adjust the nozzle to the fabric thickness can cause excess abrasion if the nozzle is positioned too low.

12.5 Adjust the vacuum suction control between 60 and 100, or to a setting high enough to remove abraded particles.

12.6 Select the desired number of test cycles and wheel loading as listed in the procedures below:

12.6.1 *Option A Heavy Duty Procedure*—Test two specimens on the fabric face for 300 cycles and two specimens on the back for 100 cycles. Use CS-10 wheels with a loading mass of 500 g/wheel.

12.6.2 *Option B Light Duty Procedure*—Test two specimens on the fabric face for 300 cycles and two specimens on the back for 50 cycles. Use CS-10 wheels with a loading mass of 250 g/wheel. (Each arm minus the auxilliary weights equals 250 g/wheel.)

12.7 After testing, raise wheels and vacuum nozzle then remove the specimen for grading. If desired, the holder may be removed from the tester by lifting straight up. This will permit a closer inspection of the specimen prior to removal from the holder.

NOTE 2—For special studies when a transparent platform to the specimen holder is used, pile loss may be observed over the viewing box with the specimen still attached to the transparent holder.

## 13. Evaluation

13.1 The operator is to rate all abraded specimens by placing them, face up, over the lighted viewing box for comparison with the Photographic Scale for Pile Retention. A viewing angle that is perpendicular to the specimen is to be used. See [Fig. 2](#). In the case of dispute or referee, three raters should be used.

13.2 The ASTM photographic scale for rating resistance to pile retention has six levels of pile retention. They are as follows:

- 5.0—Excellent
- 4.0—Good
- 3.5—Fair to good
- 3.0—Fair
- 2.0—Poor
- 1.0—Very poor

13.3 If interpolations are needed in the above list of photographic standards, only half steps may be used. Therefore, ratings are: 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5, and 5.0.

13.4 Sometimes the photographic rating levels do not compare with the wear pattern, the exact type, size and arrangement



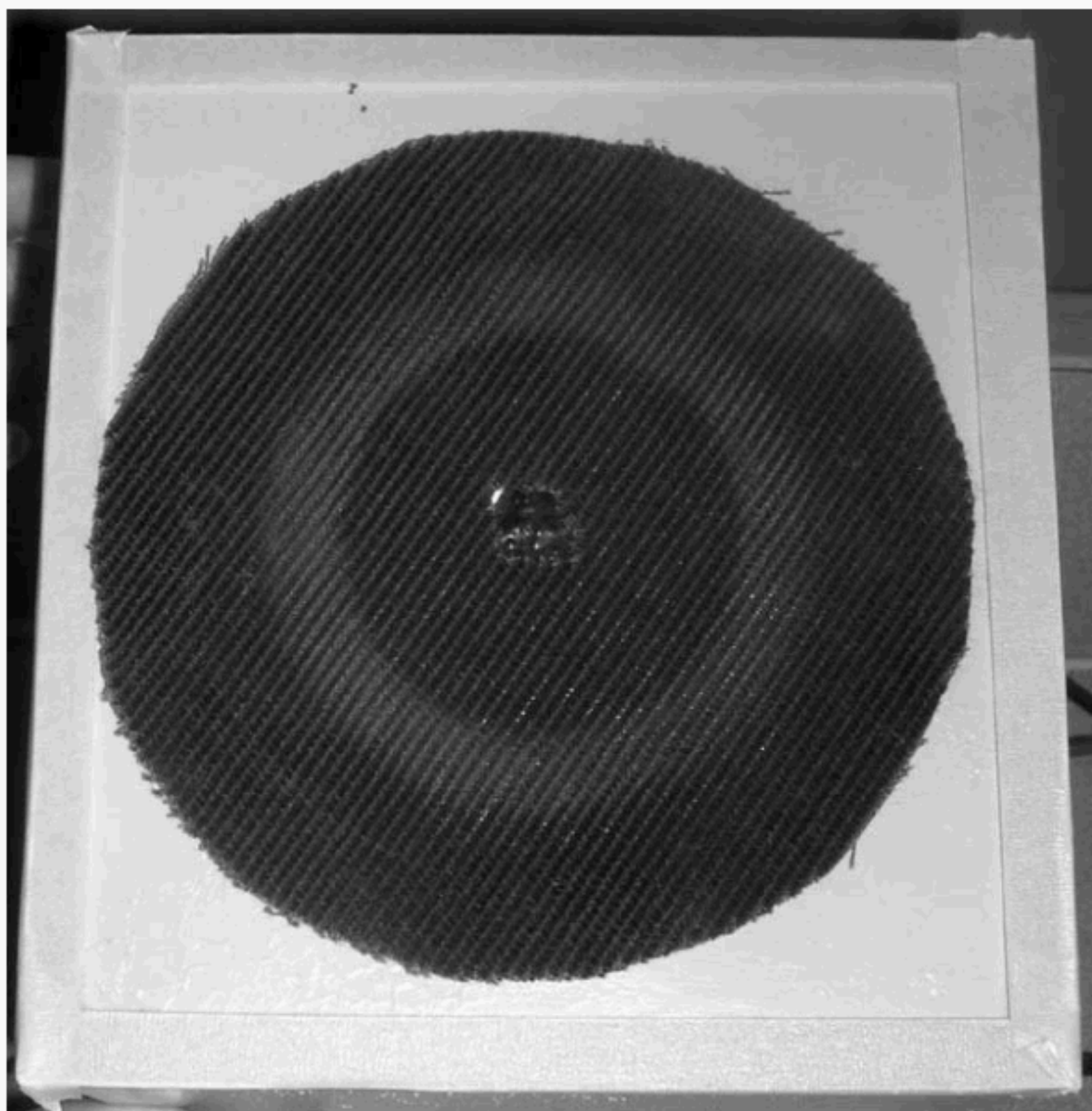


FIG. 2 Pile Retention Specimen Placement on Viewing Box

of pile pull-out in the specimen, but the grade levels can be used as a general rating guide for the population of pile loss.

13.5 Color changes, overall abrasion, matting down and fold-over of high pile, and openness of weave should not be a factor in evaluation; only the loss of pile as observed by transmitted light should be considered.

#### 14. Report

14.1 State that the specimens were tested as described in Test Method D4685/D4685M. Describe the material or product sampled, and the method of sampling used.

14.2 Report the following information:

14.2.1 Ratings on each individual specimen, the average ratings of each laboratory sample and whether or not the samples were laundered or drycleaned,

14.2.2 For those specimens washed before testing, laundering conditions used,

14.2.3 If the fabric was drycleaned before testing, drycleaning conditions used,

14.2.4 Ratings made on face and back of each set of specimens, and

14.2.5 Test options—Heavy Duty or Light Duty.

#### 15. Precision and Bias<sup>7</sup>

15.1 The precision of this test method is based on an interlaboratory study of ASTM D4685/D4685M, Standard Test

Method for Pile Fabric Abrasion. This study was completed in 2004. Three laboratories were asked to report duplicate results (and averages) for five different supplied fabrics. Every “test result” represents an individual determination or an average (as specified). Practice E691 was followed for the design and analysis of the data.

15.1.1 *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.

15.1.1.1 Repeatability can be interpreted as 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.

15.1.1.2 Repeatability limits are listed in Table 1 and Table 2.

15.1.2 *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.

15.1.2.1 Reproducibility can be interpreted as 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.

<sup>7</sup> Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:D13-1140. Contact ASTM Customer Service at service@astm.org.



**TABLE 1 Abrasion Rating – Face**

NOTE 1—Three laboratories reporting duplicates.

Material	Average <sup>A</sup> $\bar{x}$	Repeatability Standard Deviation $S_r$	Reproducibility Standard Deviation $S_R$	Repeatability Limit $r$	Reproducibility Limit $R$
5.2 oz/yd <sup>2</sup> – 22 wale corduroy	4.25	0.20	0.68	0.57	1.90
6.5 oz/yd <sup>2</sup> – 16 wale corduroy	4.17	0.41	0.41	1.14	1.14
9.4 oz/yd <sup>2</sup> – 14 wale corduroy	3.92	0.20	0.20	0.57	0.57
9.3 oz/yd <sup>2</sup> – 7 wale corduroy	2.17	0.41	0.41	1.14	1.14
8.3 oz/yd <sup>2</sup> – velveteen	3.08	0.46	1.00	1.28	2.80

<sup>A</sup> The average of the laboratories' reported averages.

**TABLE 2 Abrasion Rating – Back**

NOTE 1—Three laboratories reporting duplicates.

Material	Average <sup>A</sup> $\bar{x}$	Repeatability Standard Deviation $S_r$	Reproducibility Standard Deviation $S_R$	Repeatability Limit $r$	Reproducibility Limit $R$
5.2 oz/yd <sup>2</sup> – 22 wale corduroy	4.17	0.00	0.76	0.00	2.14
6.5 oz/yd <sup>2</sup> – 16 wale corduroy	4.83	0.41	0.41	1.14	1.14
9.4 oz/yd <sup>2</sup> – 14 wale corduroy	4.58	0.20	0.74	0.57	2.06
9.3 oz/yd <sup>2</sup> – 7 wale corduroy	4.83	0.41	0.41	1.14	1.14
8.3 oz/yd <sup>2</sup> – velveteen	2.42	0.20	0.74	0.57	2.06

<sup>A</sup> The average of the laboratories' reported averages.

15.1.2.2 Reproducibility limits are listed in [Table 1](#) and [Table 2](#) for laboratories reporting duplicates and [Table 3](#) and [Table 4](#) for laboratories reporting a single average.

15.1.3 The terms (repeatability limit and reproducibility limit) are used as specified in Practice [E177](#).

15.1.4 Any judgment in accordance with [15.1.1](#) and [15.1.2](#) would have an approximate 95 % probability of being correct.

15.2 *Bias*—No accepted reference material suitable for determining the bias for this test method was incorporated into this study, therefore no statement on bias is being made.

15.3 The precision statement was determined through statistical examination of 70 results, from three laboratories, on five materials.

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

**TABLE 3 Abrasion Rating – Face (averages)**

NOTE 1—Three laboratories reporting a single average.

Material	Average $\bar{x}$	Reproducibility Standard Deviation $S_R$	Reproducibility Limit $R$
5.2 oz/yd <sup>2</sup> – 22 wale corduroy	4.25	0.66	1.85
6.5 oz/yd <sup>2</sup> – 16 wale corduroy	4.17	0.29	0.81
9.4 oz/yd <sup>2</sup> – 14 wale corduroy	3.92	0.14	0.40
9.3 oz/yd <sup>2</sup> – 7 wale corduroy	2.17	0.29	0.81
8.3 oz/yd <sup>2</sup> – velveteen	3.08	0.95	2.65

**TABLE 4 Abrasion Rating – Back (averages)**

NOTE 1—Three laboratories reporting a single average.

Material	Average $\bar{x}$	Reproduc- ibility Stan- dard Devia- tion $S_R$	Reproduc- ibility Limit $R$
5.2 oz/yd <sup>2</sup> – 22 wale corduroy	4.17	0.76	2.14
6.5 oz/yd <sup>2</sup> – 16 wale corduroy	4.83	0.29	0.81
9.4 oz/yd <sup>2</sup> – 14 wale corduroy	4.58	0.72	2.02
9.3 oz/yd <sup>2</sup> – 7 wale corduroy	4.83	0.29	0.81
8.3 oz/yd <sup>2</sup> – velveteen	2.42	0.72	2.02

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