Designation: D3676 – 18

Standard Specification for Rubber Cellular Cushion Used for Carpet or Rug Underlay[1]

This standard is issued under the fixed designation D3676; 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 specification covers high-density cellular rubber adhered to carpet and rugs. This specification can also be applied to various substrates, such as blown sponge rubber, used independently as carpet underlay.

1.2 *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.*

NOTE 1—There is no known ISO equivalent to this standard.

1.3 *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]

D395 Test Methods for Rubber Property—Compression Set
D573 Test Method for Rubber—Deterioration in an Air Oven
D751 Test Methods for Coated Fabrics
D883 Terminology Relating to Plastics
D1056 Specification for Flexible Cellular Materials—Sponge or Expanded Rubber
D3574 Test Methods for Flexible Cellular Materials—Slab, Bonded, and Molded Urethane Foams
D3767 Practice for Rubber—Measurement of Dimensions
D6576 Specification for Flexible Cellular Rubber Chemically Blown

2.2 *Federal Standard:*

Fed. Std. No. 191 Textile Test Methods, Method 5100—Breaking Strength and Elongation of Woven Cloth; Grab Method[3]

3. Terminology

3.1 *Definitions*—For definitions used in this test method, refer to Terminology D883.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *rubber*—a material that is capable of recovering from large deformations quickly and forcibly, and can be, or already is, modified to a state in which it is essentially insoluble (but can swell) in boiling solvent (such as benzene, methyl ethyl ketone, and ethanol-toluene azeotrope).

3.2.2 *cellular material*—a generic term for materials containing many cells (either open or closed, or both) dispersed throughout the mass.

3.2.3 *flexible cellular material*—a flexible cellular organic polymeric material that will not rupture within 60 s when a specimen 8 by 1 in. (200 by 25 by 25 mm) is bent around a 1-in. (25-mm) diameter mandrel at a uniform rate of 1 lap/5 s in the form of a helix at a temperature between 65 and 85°F (18 and 29°C).

3.2.4 *open cell*—a product whose cells are not totally enclosed by its walls and open to the surface, either directly or by interconnecting with other cells.

3.2.5 *closed cell*—a product whose cells are totally enclosed by its walls and hence not interconnecting with other cells.

3.2.6 *sponge rubber*—cellular rubber consisting predominantly of open cells made from a solid rubber compound.

4. Summary of Test Method

4.1 This specification provides material and dimensional requirements and test methods for specific properties of compression set, compression resistance or compression force deflection, delamination strength, and accelerated aging.

NOTE 2—This specification does not include requirements for burning characteristics. It shall be noted that Flammable Fabrics Act Regulations FF1-70, Standard for the Surface Flammability of Carpets and Rugs, and

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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.

[3] Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111–5094, Attn: NPODS.

FF2-70, Standard for the Surface Flammability of Small Carpets and Rugs,4 shall be applicable for carpets and rugs with integral backing of rubber cellular cushion.

5. Significance and Use

5.1 The purpose of this specification is to provide meaningful tests for rubber cellular cushion used for carpet or rug underlay.

6. Classification

6.1 The following classes of flexible, cellular, high-density rubber either adhered to carpets and rugs or used independently as carpet underlay are covered.

6.1.1 *Class A,* for moderate traffic use within one and two family, multi-family, and care-type dwelling units. Moderate traffic areas are areas such as living rooms, dining rooms, bedrooms, and recreation rooms.

6.1.2 *Class B,* for heavy traffic use for public areas such as lobbies and corridors of multifamily and care-type facilities; entrances, stairways, and elevators.

7. Physical Requirements

7.1 The material shall conform to the requirements for physical properties prescribed in Table 1.

8. Sampling and Sample Preparation

8.1 Select representative samples of the lot being examined at random as required.

8.2 Each sample shall consist of a 200 ± 10-mm wide strip taken across the full width of the finished rug, carpet, or underlayment, or other substrate. For narrow products such as runners, it will occasionally be necessary to use a strip 300 mm or more to furnish all the test specimens. If the product is not homogeneous across the full width, reject the sample and obtain another sample. Prior to cutting, read the sample requirements so as to plan the cutting pattern properly.

TABLE 1

Characteristic	Class A	Class B	ASTM Method
Mass per unit area, min, kg/m^2 (oz/yd^2)	1.3 (38.0)	1.6 (46.0)	Section 12 of D3676
Thickness, min, mm (in.)	3 (0.12)	3 (0.12)	Section 13 of D3676
Density, min, kg/m^3 (lb/ft^3)	270 (17)	320 (20)	Section 14 of D3676
Compression Resistance, min, kPa (psi)	21 (3)	31 (4.5)	Section 15 of D3676
Constant deflection compression set, max, %	15	15	D395, Method B with changes as in Section 16 of D3676
Delamination resistance, min, N/min (lbf/in.)	350 (2)	350 (2)	Section 17 of D3676
Accelerated aging		Samples shall pass the stated requirements	D573 with changes as in Section 18 of D3676
Tensile strength, min, kPa (psi)	55 (8)	55 (8)	D3574
Compression Force	—	—	D3574
Deflection, KPa (psi)	—	—	

8.3 Mark off 150 mm from the outer edges of the sample and cut all specimens from inside these lines. Divide this inside width into three approximately equal parts. After cutting the specimens, identify the originating area on the foam side.

8.4 Cut three 50 ± 1 mm by 150 ± 3-mm specimens from the sample, one from each side area and one from the center and label each specimen distinguishing as such. Cut the long dimension parallel to the warp threads of the carpet or rug, if applicable.

8.5 Die-cut six 100 ± 2 mm by 100 ± 2-mm specimens, two from each side area and two from the center. Die-cut the specimens with the foam side against the cutting die.

8.6 Cut at least one 50 ± 1 mm by 100 ± 2-mm specimen from the remaining sample.

9. Test Methods

9.1 Unless specifically stated otherwise, all tests shall be made in accordance with the methods specified in Sections 11 – 18.

10. Inspection and Rejection

10.1 All tests and inspection shall be made at the place of manufacture prior to shipment unless otherwise specified.

10.2 It is acceptable for any material that fails in one or more of the test requirements to be resampled from another area and retested. Failure of the retest shall be cause for final rejection.

10.3 The manufacturer shall certify that the material is in compliance with this specification.

11. Test Conditions

11.1 Condition the specimens for a minimum of 24 h at 23 ± 2°C and 50 ± 10 % relative humidity. If other conditions are used, note these conditions in the report.

12. Area Density of Foam Backing

12.1 *Procedure*—Weigh the six 100 mm by 100-mm specimens separately and record the mass to the nearest 0.01 g. Using suitable equipment, for example, an electric carving knife and supporting guides, separate the foam backing from the primary carpet backing by cutting at the line where the textile component meets the foam component. Cut as closely as possible without damaging the primary carpet backing. Keep the foam specimens for further tests. Remove any remaining foam from the primary carpet backing by brushing it with a stiff wire-bristle brush. Weigh each carpet specimen separately and record the mass to the nearest 0.01 g.

12.2 *Calculation*—For each specimen, calculate the mass (M) of the foam as the difference between the total mass and the mass of the carpet with foam backing removed. Report the average of the six results. Calculate the mass per unit area in kilograms per square metre by dividing the average mass by the area of the specimen. (For specimens 100 mm by 100 mm (4 in. by 4 in.), the area density in kilograms per square metre = 0.1 M, when M is expressed in grams.)

12.3 *Precision and Bias*—See Test Methods D3574, Test A.

13. Thickness

13.1 *Procedure*—Measure the thickness of each of the six 100 mm by 100-mm foam specimens to the nearest 0.02 mm, by means of a thickness gage having a circular presser foot with an area of 645 mm^2 and exerting a pressure of 1.5 kPa. Apply the force slowly without impact and read the thickness gage immediately. Report the average of the six readings.

13.2 *Precision and Bias*—See Practice D3767, Method A2.

14. Volume Density

14.1 *Procedure*—Weigh each of the six 100 mm by 100-mm (4 in. by 4-in.) foam specimens to the nearest 0.01 g.

14.2 *Calculation*—Calculate the density for each specimen as follows:

$$d = 100M/T \quad (1)$$

where:

d = density, kg/m^3,
M = Mass, g, and
T = Thickness, mm.

Report the average of the six determinations.

14.3 *Precision and Bias*—See Test Methods D3574, Test A.

15. Compression Resistance

15.1 *Procedure*—Cut each of the 100 mm by 100-mm foam specimens into four 50 mm by 50-mm specimens. Form two sets of plied specimens approximately 25-mm thick, skin side to cut side. Place the plied specimen in a compression tester and, with a presser foot that is larger than the surface area of the specimen, determine the total thickness of the plied specimen with a pre-stress of 1.5 kPa. Compress the plied specimen to 75 ± 1 % of its original thickness at 0.83 ± 0.08 mm/s and immediately determine the total force in kN. Report the average of the two results.

15.2 *Calculation*—Calculate the compression resistance as follows:

$$C_R = (A/B) - D \quad (2)$$

where:

C_R = compression resistance, kPa,
A = force, kN,
B = area, m^2, and
D = Pre-stress of 1.5 kPa.

(For a specimen 50 mm by 50 mm, the compression resistance in kilopascals = (0.4 A) − 1.5, when A is expressed in newtons.)

15.3 *Precision and Bias*—See Specification D1056, Compression Deflection Tests.

16. Constant Deflection Compression Set

16.1 *Procedure*—Form two additional sets of plied specimens 50 mm by 50 mm, approximately 25 mm thick, skin side to cut side, using specimens from the compression resistance test if necessary. Determine the thickness of the plied specimens in accordance with Section 13 and use this plied specimen thickness as the original thickness. Place the plied specimens in a fixture consisting of two parallel plates larger than the specimen in surface area. Compress the specimen to 50 ± 1 % of its original thickness as determined above, using appropriate spacers to maintain the required thickness. Place the fixture with the compressed specimen in a circulating air oven at 70 ± 1°C for 22 ± 0.5 h. Remove the fixture from the oven, unclamp immediately, and remove the plied specimen from the fixture. Remeasure the thickness of the plied specimen in accordance with Section 13 after a 4.5 ± 0.5 h recovery. If the plies adhere together after the oven treatment, do not separate them before remeasuring. Report the average of the two results.

16.2 *Calculation*—Calculate the constant deflection compression set expressed as a percentage loss of the original thickness:

$$C_t = 100(t_o - t_f)/t_o \quad (3)$$

where:

C_t = compression set, %,
t_o = original thickness, mm (in.), and
t_f = final thickness, mm (in.).

16.3 *Precision and Bias*—See Test Methods D395, Test B.

17. Delamination Resistance

17.1 *Procedure*—Take the three 50 mm by 150-mm specimens and cover the foam side with self-adhering tape in order to add support to the foam backing as it is being separated from the carpet backing. Separate the foam backing from the primary carpet backing for approximately 40 mm at one end of the specimen. Use a tensile tester equivalent to that described in Method 5100 of Fed. Std. No. 191 or Test Methods D751. Set the clamps of the tensile tester 25 mm apart and clamp the loose end of the attached foam in the lower clamp and the loose end of the carpet in the upper clamp. The clamps must be as wide as the specimen, 50 mm. Select a speed of 5 mm/s and start the tester to pull the specimen apart. Take the average of the five high peaks on the recording chart to determine the force in newtons.

17.2 *Calculation*—Calculate the delamination resistance for each specimen as follows:

$$D_r = F/W \quad (4)$$

where:

D_r = delamination resistance, kN/m,
F = force required, N, and
W = width of specimen, mm.

Report the average of the three results.

17.3 *Precision and Bias*—See Test Methods D751. Adhesion of Coating to Fabric.

18. Accelerated Aging

18.1 *Procedure*—Place a 50 mm (nominal) by 100-mm (nominal) specimen of the material in a circulating air oven at 135 ± 5°C for 24 h +0.5, –0 hour.

18.2 *Examination*—Specimens need to withstand this exposure with no more than a slight discoloration or surface degradation, or both. After cooling to ambient temperature,

bend the sample 180° so that the two ends meet and the foam side is outermost. A slight cracking or crazing is acceptable. Total rupture of the foam is not acceptable. Report as pass or fail. In case of failure report the failure mode.

18.3 *Precision and Bias*—A statement about precision and bias is not made since the result merely states pass or fail.

19. Compression Force Deflection Test

19.1 When required Compression Force Deflection (CFD) is to be tested, use Test Method D3574, Test C.

NOTE 3—This method has become the preferred test for measuring the firmness of carpet cushion.

19.2 Test material must be at least 6.35 mm thick. If the specimen is less than 6.35-mm, it must be plied up to at least 6.35-mm.

19.3 Typical CFD tests are 25 %, 50 %, 65 %, although the customer is entitled to specify other deflections. Fifty percent deflection is the default unless otherwise agreed upon by the contractual parties.

19.4 *Precision and Bias*—See Test Method D3574, Test C.

20. Packaging and Package Marking

20.1 The material shall be packaged properly and adequately. Each package or container shall be marked legibly with the name and size of the material, name or trademark of the manufacturer, and any required purchaser's designations.

21. Keywords

21.1 carpet cushion specification; flexible cellular materials; rubber

APPENDIX

X1. CR VERSUS CFD

INTRODUCTION

These correlation equations for Compression Resistance (CR) in accordance with D3676 and Compression Force Deflection (CFD) in accordance with D3574 were determined from the testing of 19 different types and grades of rubber carpet underlays in 2007. This included flat rubber, textured rubber, waffle rubber, and recycled rubber products ranging in weights from 60 to 120 oz/yd. The R^2 numbers from the statistical data fits were very high showing excellent correlation between the two tests.

X1.1 Correlation Equations

X1.1.1 *25 % Deflection:*

$$x = .082\ (y - 3.35)^2 + 0.56y - 0.42 \quad R^2 = 0.96$$

where:

x = 25 % CFD
y = 25 % CR

X1.1.2 *50 % Deflection:*

$$x = .005\ (y - 10.63)^2 + 0.6y - 0.86 \quad R^2 = 0.99$$

where:

x = 50 % CFD
y = 50 % CR

X1.1.3 *65 % Deflection:*

$$x = .001\ (y - 24.26)^2 + 0.71y - 2.09 \quad R^2 = 0.99$$

where:

x = 65 % CFD
y = 65 % CR