Designation: D3768 – 16

Standard Test Method for Microcellular Urethanes—Flexural Recovery[1]

This standard is issued under the fixed designation D3768; 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 covers the procedure and apparatus for measuring the flexural recovery of microcellular urethanes.

1.2 The values stated in SI units are to be regarded as standard.

1.3 *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.*

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

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D883 Terminology Relating to Plastics

D3040 Practice for Preparing Precision Statements for Standards Related to Rubber and Rubber Testing (Withdrawn 1987)[3]

D3489 Test Methods for Microcellular Urethane Materials

E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

3. Terminology

3.1 For definitions of terms used in this test method and associated with plastics issues, refer to terminology contained in Terminology D883.

3.2 The following definition is from Test Methods D3489:

3.2.1 *microcellular urethane, n*—an elastomeric material made by the interaction of a polyol and an organic isocyanate, having cell diameters in the range from 0.0001 to 0.001 mm, with a minimum density of 160 kg/m^3 (10 lb/ft^3).

4. Significance and Use

4.1 This test method is used to indicate the ability of a material to recover after a 180° bend around a 12.7-mm (0.5-in.) diameter mandrel at room temperature.

4.2 Before proceeding with this test method, reference shall be made to any specification for the material being tested. Any test specimen preparation, conditioning, or dimensions, or combination thereof, and testing parameters covered in the materials specification shall take precedence over those mentioned in these test methods. If there are no material specifications, then the default conditions apply.

NOTE 2—This test method is applicable to solid urethanes.

5. Apparatus

5.1 *Flexural Recovery Test Fixture*—The test fixture shall consist of a 12.7-mm diameter mandrel mounted to a base equipped with a protractor. A drawing of a typical test fixture is shown in Fig. 1.

5.2 *Timer,* capable of indicating seconds.

5.3 *Thickness Indicator,* accurate to 0.03 mm.

6. Test Specimens

6.1 The test specimens shall be cut from molded plaques or parts. The recommended standard test specimen is 4 mm in thickness, and the minimum specimen thickness shall not be less than 3 mm. The specimen shall be 25 mm in width by 150 mm in length (1 by 6 in.).

7. Conditioning

7.1 *Conditioning*—Condition the test specimens and the test fixture at 23 ± 2°C (73.4 ± 3.6°F) and 50 ± 10 % relative humidity for not less than 24 h prior to testing, unless otherwise specified.

7.2 *Test Conditions*—Conduct tests in the standard laboratory atmosphere of 23 ± 2°C (73.4 ± 3.6°F) and 50 ± 10 % relative humidity, unless otherwise specified.

8. Procedure

8.1 There shall be at least three recovery measurements.

8.2 Measure the thickness of specimen to the nearest 0.03 mm.

[1] This test method is under the jurisdiction of ASTM Committee D20 on Plastics and is the direct responsibility of Subcommittee D20.22 on Cellular Materials - Plastics and Elastomers.

Current edition approved Oct. 1, 2016. Published October 2016. Originally approved in 1979. Last previous edition approved in 2011 as D3768 - 11. DOI: 10.1520/D3768-16.

[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] The last approved version of this historical standard is referenced on www.astm.org.

***A Summary of Changes section appears at the end of this standard**

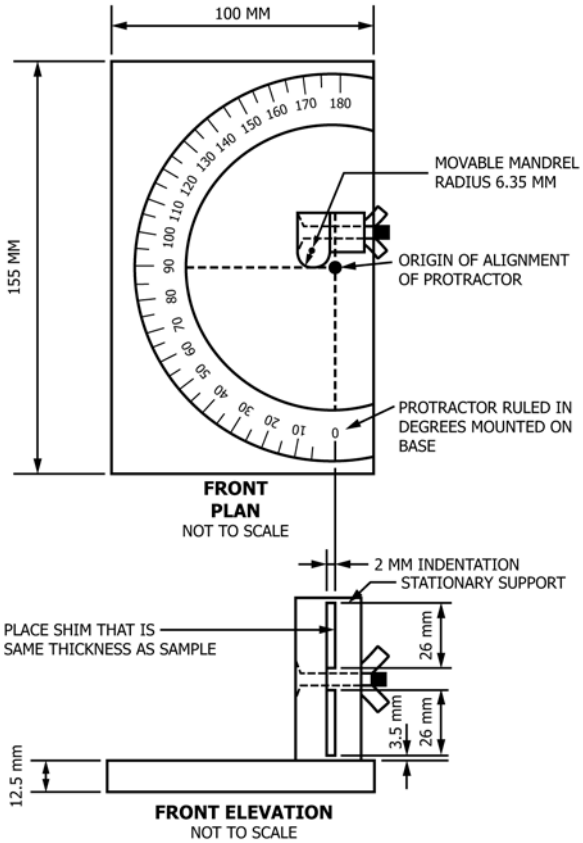

FIG. 1 Example Fixture for Flexural Recovery Test

8.3 Insert the test specimen in the lower slot of the specimen clamp and position the end of the specimen flush with the rear face of the bend mandrel. Tighten the clamp while holding the specimen in a horizontal position. (Do not allow the outer end of the specimen to be in contact with the base of the test fixture.) A spacer of approximately the same thickness as the test specimen must be used in the upper slot to ensure proper clamping in the lower slot. A specimen mounted in a test fixture at the start of a test is shown in Fig. 2.

8.4 Make an initial reading where the mandrel edge of the specimen (the surface of the test specimen that is in contact with the bend mandrel) intercepts the protractor scale. Make a reading to the nearest 1° and record the value.

8.5 Apply force approximately 30 mm (1.25 in.) from the clamp and bend the specimen 180° around the mandrel. Hold the specimen for 5 ± 1 s in the bent position, then release slowly and allow to recover. Start the timer immediately upon release. Do not allow the specimen to drag on the fixture base during recovery. A specimen that is being bent 180° around the mandrel is shown in Fig. 3.

8.6 Read the intercept of the mandrel edge of the specimen on the protractor scale after 30-s and 300-s recovery. The difference between these readings and the initial reading is the appropriate flexural recovery value in degrees.

9. Calculation

9.1 The intercept of the mandrel edge of the specimen on the protractor scale in degrees = φ.

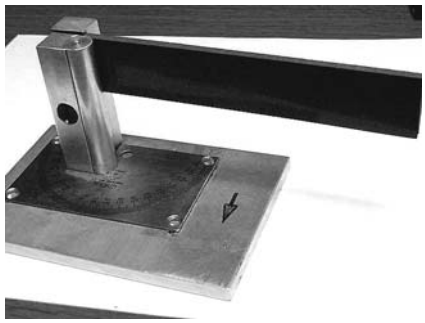

FIG. 2 Specimen Mounted in Fixture

FIG. 3 Specimen Being Bent Around Mandrel

9.2 The flexural set after 30 s is given by:
Flexural Set (30 s) = φ30 s − φ0 (see Note 3).

9.3 The flexural set after 300 s is given by:
Flexural Set (300 s) = φ300 s − φ0 (see Note 3).

NOTE 3—This measurement in the automotive industry is customarily referred to as recovery.

10. Report

10.1 The report shall include the following:
10.1.1 Direction of cutting,
10.1.2 Conditioning procedures before testing,
10.1.3 Flexural set (30 s), average of three,
10.1.4 Flexural set (300 s), average of three, and
10.1.5 Sample thickness.

11. Precision and Bias

11.1 Table 1 is based on a round robin[4] conducted in 1980 in accordance with Practice D3040, involving three materials tested by four laboratories. For each material, all the samples were prepared at one source and the individual specimens were also prepared at one source. Each test result consisted of one individual determination. Each laboratory obtained four test results for each material. (**Warning—**The explanation of *r* (11.2 – 11.2.2) is only intended to present a meaningful way of considering the approximate precision of these test methods. The data in Table 1 shall not be applied to acceptance or rejection of materials, as these data apply only to the materials tested in the round robin and are unlikely to be rigorously representative of other lots, formulations, conditions, materials,

[4] Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:D20-1191.

TABLE 1 Precision for Flexural Recovery Test[A]

Property	Material	Flexural Modulus, MPa (psi)	Average	S_r[B]	r[C]
Flexural set (30 s)	Urethane A	700 (100 000)	14.22	0.751	2.10
	Urethane B	350 (50 000)	13.77	0.812	2.27
	Urethane C	175 (25 000)	10.32	1.488	4.17
Flexural set (300 s)	Urethane A	700 (100 000)	9.08	0.849	2.38
	Urethane B	350 (50 000)	8.38	0.660	1.85
	Urethane C	175 (25 000)	5.69	0.785	2.20

[A] Values expressed in units of degrees.
[B] S_r = within-laboratory standard deviation for the indicated material. It is obtained by pooling the within-laboratory standard deviations of the test results from all of the participating laboratories:

$$S_r = [[(s_1)^2 + (s_2)^2 \cdots + (s_n)^2]/n]^{1/2}$$

[C] r = within-laboratory critical interval between two test results = 2.8 × S_r.

or laboratories. Users of this test method shall apply the principles outlined in Practice E691 to generate data specific to their materials and laboratory (or between specific laboratories). The principles of 11.2 – 11.2.2 would then be valid for such data.)

11.2 *Concept of r in* Table 1—If S_r has been calculated from a large enough body of data, and for test results that were averages from testing three specimens for each test result, then:

11.2.1 *Repeatability*—Two test results obtained within one laboratory shall be judged not equivalent if they differ by more than the *r* value of 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.

11.2.2 Any judgment in accordance with 11.2.1 would have an approximate 95 % (0.95) probability of being correct.

11.3 There are no recognized standards by which to estimate bias of this test method.

12. Keywords

12.1 flexural; microcellular; recovery; urethane

SUMMARY OF CHANGES

Committee D20 has identified the location of selected changes to this standard since the last issue, D3768 - 11, that may impact the use of this standard. (October 1, 2016)

(1) Added referenced documents D883 and D3489 to Section 2.

(2) Added new Terminology, Section 3, and renumbered subsequent sections.

(3) Removed non-mandatory language from mandatory sections.