Designation: D 3768 – 96 (Reapproved 2000)

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

This standard is issued under the fixed designation D 3768; 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 the 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 similar or equivalent ISO standard to this test method.

2. Referenced Documents

2.1 *ASTM Standards:*

D 3040 Practice for Preparing Precision Statements for Standards Related to Rubber and Rubber Testing[2]

E 691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method[3]

3. Significance and Use

3.1 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.

3.2 Before proceeding with this test method, reference should be made to the specification of 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 may be applied to solid urethanes.

4. Apparatus

4.1 *Flexural Recovery Test Fixture*— See Fig. 1.

4.2 *Timer*, capable of indicating seconds.

4.3 *Thickness Indicator*, accurate to 0.25 mm.

5. Test Specimens

5.1 The test specimens shall be die cut from molded plaques or parts. The specimen size shall be 25 mm in width by 150 mm in length (1 by 6 in.). The recommended standard test specimen is 4 mm in thickness. Thinner specimens may be used, but shall not be less than 3 mm.

6. Conditioning

6.1 Unless otherwise specified, condition the specimens and fixtures a minimum of 1 h at 23 ± 2°C and 50 ± 5 % relative humidity before testing.

7. Procedure

7.1 There shall be at least three recovery measurements.

7.2 Measure the thickness of specimen to the nearest 0.25 mm.

7.3 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.

7.4 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.

7.5 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.

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[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 August 10, 1996. Published February 1997. Originally published as D 3768 – 79. Last previous edition D 3768 – 85 (1990).

This revision includes the addition of the following: an ISO equivalency statement, a materials specification statement, and a keyword section.

[2] Discontinued—see *1986 Annual Book of ASTM Standards*, Vols 09.01 and 09.02.

[3] *Annual Book of ASTM Standards*, Vol 14.02.

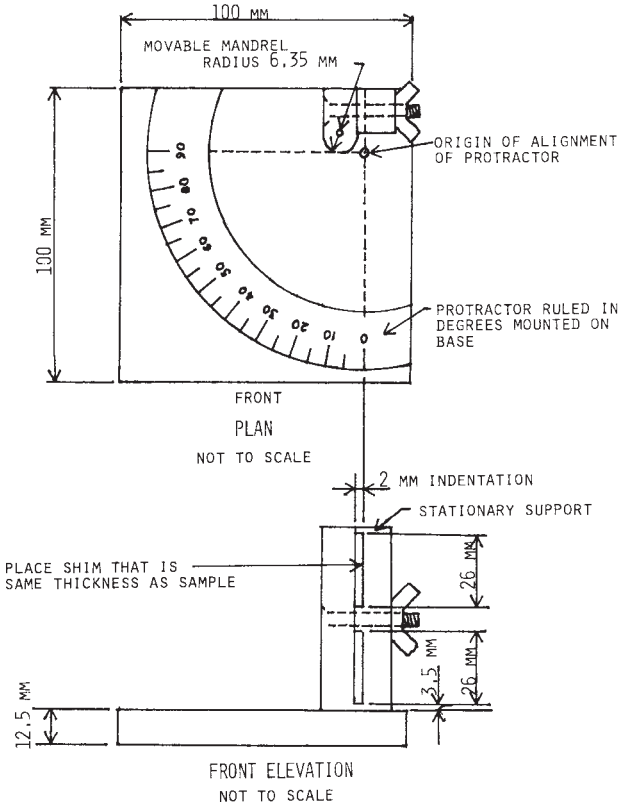

FIG. 1 Fixture for Flexural Recovery Test

7.6 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.

8. Calculation

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

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

8.3 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.

9. Report

9.1 The report shall include the following:
9.1.1 Direction of cutting,
9.1.2 Conditioning procedures before testing,
9.1.3 Flexural set (30 s), average of three,
9.1.4 Flexural set (300 s), average of three, and
9.1.5 Sample thickness.

10. Precision and Bias

10.1 Table 1 is based on a round robin[4] conducted in 1980 in accordance with Practice D 3040, 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.

NOTE 4—**Caution:** : The explanation of *r* (10.2-10.2.2) is only intended to present a meaningful way of considering the approximate precision of these test methods. The data in Table 1 should 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, or laboratories. Users of this test method should apply the principles outlined in Practice E 691 to generate data specific to their materials and laboratory (or between specific laboratories). The principles of 10.2-10.2.2 would then be valid for such data.

10.2 *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:

10.2.1 *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.

10.2.2 Any judgment in accordance with 10.2.1 would have an approximate 95 % (0.95) probability of being correct.

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

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.

[4] Supporting data are available from ASTM Headquarters.

11. Keywords

11.1 flexural; microcellular; recovery; urethane