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Standard Test Method for Flexibility of Resilient Flooring Materials with Cylindrical Mandrel Apparatus[1]

This standard is issued under the fixed designation F137; 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 determination of the flexibility of resilient flooring materials by means of cylindrical mandrel apparatus. It is especially applicable to sheet goods and some tiles.

1.2 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.

1.3 *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 to determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

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

F141 Terminology Relating to Resilient Floor Coverings

3. Terminology

3.1 For definitions, refer to Terminology F141.

4. Significance and Use

4.1 Flexibility is that property of a material which allows it to be deformed by bending or rolling without cracking, breaking, or other permanent defects, using whatever force is necessary to bend or roll it. Flexibility is an important characteristic of flooring in that it provides for ease of handling in rolling, cutting, and fitting.

5. Apparatus

5.1 *Flexibility Test Equipment,* consisting of mandrels, that is, cylindrical rods with circular cross sections having outside diameters of 0.25 in. (6.4 mm) and 0.50 to 5 in. (12.7 to 127 mm) increasing in increments of 0.5 in. (12.7 mm). The contacting faces of the rods shall be a minimum of 2.5 in. (63.5 mm) in length.

5.2 *Stand or Other Device,* to firmly support the mandrel in a horizontal position during the test.

5.3 *Conditioning Area,* capable of maintaining 73.4 ± 1.8°F (23 ± 1°C) and 50 ± 5 % relative humidity.

5.4 *Die, Knife, or Similar Instrument* to prepare test specimens with uniform smooth edges.

6. Test Specimen

6.1 The test specimens shall consist of a portion of the material 2 ± 0.05 in. (50 ± 1.27 mm) wide and at least 9 in. (225 mm) long.

6.2 Use a die, knife, or other similar instrument to prepare the specimen and to produce uniform smooth edges. Do not test specimens with nicked or fractured edges.

7. Conditioning

7.1 Condition the test specimens for at least 24 h at 73.4 ± 1.8°F (23 ± 1°C) and 50 ± 5 % relative humidity, and test in the same environment. Alternatively, testing may be performed at room temperature in an uncontrolled environment if carried out within 5 min.

7.2 Specimens shall be conditioned on a flat surface. If necessary, they can be weighted to remove all curvature.

8. Procedure

8.1 In the actual flexing of the specimen, place the specimen over a mandrel with the wearing surface face out and the major axis of the specimen perpendicular to the major axis of the mandrel.

8.2 Bend the material around the mandrel at a uniform rate through a 180° angle while holding the specimen at each end.

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[1] This test method is under the jurisdiction of ASTM Committee F06 on Resilient Floor Coverings and is the direct responsibility of Subcommittee F06.20 on Test Methods - Products Construction/Materials.

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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.

Take 3 to 5 s to complete the bend. Maintain a good contact between specimen and mandrel.

8.3 Examine the specimen face visually in the bent position for breaks, cracks, or other damage at the completion of the bending operation. When required by the detailed specification, straighten the specimen at the same rate at which it was bent and examine the back for the same faults.

8.4 When a mandrel of particular diameter has been specified, as for a purchase specification, use that mandrel.

8.5 Determine the smallest mandrel around which the material may be bent without showing breaks, cracks, or other damage. To do this, estimate the size of the mandrel over which the specimen will not break. Then use a series of mandrels, each one consecutively smaller than the first, until breaks or cracks are exhibited. Start with a fresh specimen for each separate flex.

8.6 The exact number of test on a specified mandrel (8.4) or of the smallest mandrel around which the material will not break (8.5) shall be as specified in the given purchaser specification. In any case, make at least two separate determinations with the long dimension of the specimen parallel to the machine direction or grain of the material and two separate determinations with the long dimension perpendicular to the machine direction (MD) of the material.

NOTE 1—When the MD cannot be determined by the appearance of the material, two specimens shall be cut parallel to one edge of the material and two perpendicular to that set. Report that a MD could not be determined.

8.7 Repeat 8.1, 8.4, and 8.6 or 8.1, 8.5, and 8.6 with the specimen face inside against the mandrel. Examine the back, while the specimen is still in the bent position, for cracks, breaks, or other damage. Then straighten the specimens and examine the wearing surface. Use untested specimens for the face inward part of the test.

9. Precautions

9.1 When comparing materials the thicknesses should be approximately the same.

9.2 Avoid warming the specimens by hand.

9.3 Be careful in handling the specimens so that they are not flexed before testing.

10. Report

10.1 When the material is required to pass a specified mandrel, report the passing or failing of each specimen relative to this mandrel. The passing criteria is that neither the face nor the back may exhibit breaks, cracks, or other permanent damage (a different size mandrel may be specified for machine and cross-machine direction).

10.2 If no mandrel diameter is specified, report the smallest mandrel around which the material may be bent without showing breaks, cracks, or other permanent damage. Average the determinations in each direction (machine and cross machine) and report separately.

TABLE 1 Precision Data

NOTE 1—Materials A and B passed at the smallest mandrel with 100 % agreement in test results.

Materials	Average[A]	Sr[B]	SR[C]	r[D]	R[E]
Material A	0.25000	0.00000	0.00000	0.00000	0.00000
Material B	0.25000	0.00000	0.00000	0.00000	0.00000
Material C	1.13889	0.05893	0.20750	0.16499	0.58100
Material D	0.41667	0.00000	0.12910	0.00000	0.36148
Material E	0.90278	0.10206	0.27344	0.28577	0.76563
Material F	1.250000	0/13176	0.26960	0.36893	0.75489
Material G	1.27778	0.11785	0.28382	0.32998	0.79470
Material H	1.84722	0.13176	0.62491	0.36893	1.74974

[A] Average is the numerical average of test results for all replicates from all laboratories.
[B] Sr is the within-laboratory standard deviation of the average.
[C] r = 2.83 Sr.
[D] SR is the between-laboratory standard deviation of the average.
[E] R = 2.83 SR.

Repeatability = In comparing two average values for the same material obtained by the same operator using the same equipment on the same day, the means should be judged not equivalent if they differ by more than the r value for that material and condition.

Reproducibility = In comparing two average values for the same material obtained by different equipment on different days, the means should be judged not equivalent if they differ by more than the R value for that material and condition. (This applies between different laboratories or between different equipment within the same laboratory.) These judgments will have an approximate 0.95 (95%) probability of being correct. Other material may give somewhat different results. For further information on the methodology used, consult Practice E691.

11. Precision and Bias[3]

11.1 The precision for this test method was determined on four different materials including, homogeneous sheet vinyl, inlaid sheet vinyl, linoleum sheet and solid vinyl tile. Materials were tested in both a face-in and face-out orientaition, but in the machine direction (MD) only.

11.2 The number of laboratories, materials, and determinations in this study meets the minimum requirements for determining precision prescribed in Practice E691.

This Study		Practice E691 minimum
Laboratories:	6	6
Materials:	8	4
Determinations:	3	2

11.3 Precision, characterized by repeatability, Sr, r, and reproducibility, SR, R has been determined and listed in Table 1.

11.4 *Bias*—No information can be presented on the bias of the test method procedure because material having an accepted reference value is unavailable.

12. Keywords

12.1 cracks; flexibility; flooring; mandrel; resilient

[3] Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:F06-1008.