



Standard Test Methods for Preformed Expansion Joint Fillers for Concrete Construction (Nonextruding and Resilient Types)¹

This standard is issued under the fixed designation D 545; 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 Department of Defense.

1. Scope

1.1 These test methods cover the physical properties associated with preformed expansion joint fillers. The test methods include:

Property	Section
Asphalt content	7.5
Boiling in hydrochloric acid	7.4
Compression	7.2
Density	7.7
Expansion in boiling water	7.1
Extrusion	7.3
Recovery	7.2
Water absorption	7.6

1.2 The values stated in inch-pound are to be regarded as standard.

NOTE 1—Specific test methods are applicable only to certain types of joint fillers, as stated herein.

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 consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:

D 147 Methods of Testing Bituminous Mastics, Grouts, and Like Mixtures²

D 1037 Methods for Evaluating the Properties of Wood-Base Fiber and Particle Panel Materials³

3. Significance and Use

3.1 The compression resistance perpendicular to the faces, the resistance to the extrusion during compression, and the ability to recover after release of the load are indicative of a joint filler's ability to fill continuously a concrete expansion joint and thereby prevent damage that might otherwise occur during thermal expansion. The asphalt content is a measure of

the fiber-type joint filler's durability and life expectancy. In the case of cork-type fillers, the resistance to water absorption and resistance to boiling hydrochloric acid are relative measures of durability and life expectancy.

4. Apparatus

4.1 *Balance*, for weighing joint fillers capable of weighing test specimens within 0.01 g.

4.2 *Mechanical Convection Oven*, capable of maintaining $220 \pm 5.0^\circ\text{F}$ [$104 \pm 3^\circ\text{C}$].

4.3 *Desiccator*, of sufficient size to accommodate the test specimens.

4.4 *Vernier Caliper*, for measuring length and width of specimens with accuracy within ± 0.01 in. [0.25 mm].

4.5 *Dial Micrometer*, or other measuring device, graduated to read in 0.001-in. [0.02-mm] units.

4.6 *Extrusion Mold*— Three-sided steel mold to confine lateral movement of specimens under compression to one side only. Interior dimensions shall be 4 by 4 in. [102 by 102 mm] with permissible variations in length and width of ± 0.015 in. [0.38 mm]. Mold sides shall be of such height as to extend at least 0.5 in. [13 mm] above the test specimens. A typical mold can be made from a steel base $\frac{1}{2}$ by 4 by 4 ± 0.015 in. [13 by 102 by 102 ± 0.3 mm] and three bolted steel side plates $\frac{1}{4}$ in. [6.35 mm] thick, extending approximately $1\frac{1}{2}$ in. [38 mm] above the base plate, thus forming a three-sided open-top box.

4.7 *Template*—One steel template 4 by 4 in. [102 by 102 mm], machined from $\frac{1}{2}$ -in. [6.4-mm] steel plate to fit the extrusion mold. The template shall fit the mold within -0.005 in. [0.13 mm] in length and width.

4.8 *Metal Plate*, $4\frac{1}{2}$ by $4\frac{1}{2}$ in. ± 0.1 in. [114 by 114 ± 2.5 mm] with parallel faces machined from $\frac{1}{2}$ -in. [6.4-mm] steel plate.

4.9 *Compression Tester*, either hydraulic- or screw-type equipment with sufficient opening between upper- and lower-bearing surfaces to permit the use of verifying apparatus. The load applied to the test specimen shall be indicated with an accuracy of $\pm 1.0\%$. The upper-bearing device shall be a spherically seated, hardened metal block firmly attached at the center of the upper head of the machine. The center of the sphere shall lie at the center of the surface of the block in contact with the specimen. The block shall be closely held in its spherical seat, but free to tilt in any direction. Load shall be

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² Discontinued, See 1989 Annual Book of ASTM Standards, Vol 04.04.

³ Annual Book of ASTM Standards, Vol 04.10.

applied without shock at 0.05 in. [1.3 mm] per minute.

4.10 *Extractor Apparatus*, similar to Fig. 1 of Methods D 147 with thermostatically controlled heating element.

5. Sampling

5.1 One representative sample approximately 2 ft²/1000 ft² of joint filler shall be obtained and properly packaged for safe transporting to the testing agency.

5.2 For self-expanding cork joint filler, a minimum of five 4½- by 4½-in. (114- by 114-mm) square specimens properly banded and plastic wrapped at point of manufacture shall be submitted for testing.

6. Preparation of Test Specimens

6.1 For the joint fillers made of cork, sponge rubber, bituminous cork, or fiber, cut five specimens 4 by 4 in. [102 by 102 mm]. Each specimen shall be freshly and squarely cut using a metal plate as a cutting template, as described in 4.7.

6.2 For self-expanding cork only, after boiling the specimens in water as described in 7.1.1, air dry in ambient air 24 h. Then cut specimens to the size described in 6.1.

6.3 Determine the thickness of each specimen to the nearest 0.001 in. [0.03 mm].

7. Procedures

7.1 Expansion in Boiling Water:

7.1.1 For self-expanding cork joint filler only, use five of the test specimens supplied by the manufacture as described in 5.2. Determine the thickness of each specimen to the nearest 0.001 in. [0.03 mm]. Immerse the specimens in boiling water for 1 h; remove and allow to cool to room temperature for 15 min. Measure the final thickness of each specimen to the nearest 0.001 in. Calculate the expansion as follows:

$$\text{Expansion, \% of original thickness} = \frac{A}{B} \times 100 \quad (1)$$

where:

A = thickness in inches after boiling in water and

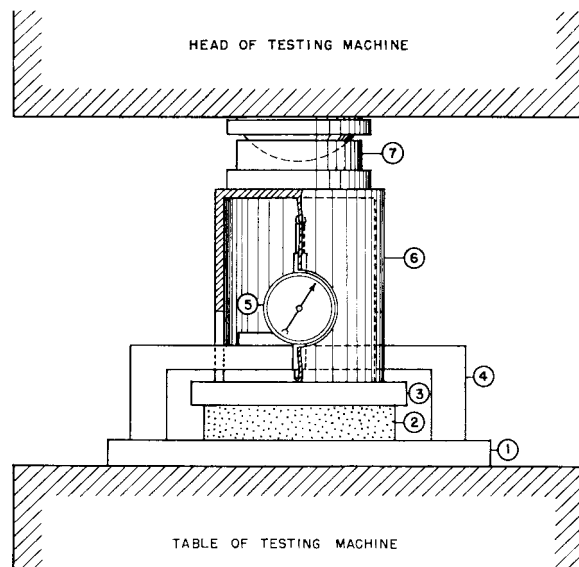
B = thickness in inches before boiling in water.

7.1.2 Prepare the test specimens for testing as described in 6.2.

7.2 Recovery and Compression:

7.2.1 *Test Specimen*—For these tests use one of the specimens prepared and described in 6.1 and 6.2. For the cork, sponge rubber, bituminous cork, and fiber joint fillers make these tests on material as received. If the cork filler fails to meet the specified requirements, make check tests on specimens that have been immersed in water for 24 h and then air-dried at ambient conditions for 24 h. Acceptance is based on the results of the check tests.

7.2.2 *Mounting*—Place the test specimen on a flat metal plate and center a 4- by 4½- by ½-in. [114- by 114- by 13- mm] metal plate, ground to have plane parallel faces, on the top surface of the specimen. Use a simple U-shaped bridge to support a dial gage or other suitable measuring device reading to the nearest 0.001 in. [0.03 mm] above the center of the specimen. Place a hollow metal load transfer cylinder with slots for inserting the U-shape bridge and an opening for reading the measuring device between the moving head of the testing machine and the plate covering the specimen. A typical mounting is shown in Fig. 1, but other suitable devices may be used. Mount a spherical bearing block between the upper end of the cylinder and the moving head of the testing machine. Center accurately both the hollow metal cylinder or other device and the spherical bearing block so that the load will be applied uniformly to the test specimen.



- 1—Flat Metal Plate.
- 2—Specimen.
- 3—Metal Plate 4½ by 4½ by ½ in. (102 by 102 by 13 mm).
- 4—U-Shape Bridge.
- 5—Measuring Device.
- 6—Hollow Cylinder.
- 7—Spherical Bearing Block.

FIG. 1 Typical Mounting of the Specimen for Recovery and Compression Tests

7.2.3 Measurement of Thickness—When the specimen has been mounted as described in 7.2.2 and is subjected only to the pressure of the dead weight of the 4½- by 4½- by ½-in. [114- by 114- by 13-mm] metal plate, determine its thickness by means of the measuring device. When the load-transferring apparatus and spherical bearing block are placed on the test specimen, some compression may result. Consider this reduction in thickness as part of the 50 % reduction in thickness to be applied.

7.2.4 Recovery—For the determination of the percentage of recovery, give the specimen a single application of a load sufficient to compress it to 50 % of its thickness before test. Apply the load without shock and at such a rate that the specimen will be compressed approximately 0.05 in. [1.3 mm]/min. Record this applied load. Immediately release the load after application and permit to recover 10 min after which, measure the thickness. Remove the load-transferring apparatus and spherical bearing block from the test specimen following the load application. Calculate the percentage of recovery as follows:

$$\text{Recovery, \%} = \frac{t_1}{t} \times 100 \quad (2)$$

where:

- t = thickness of the specimen before test and
- t_1 = thickness 10 min after completion of the application of load.

7.2.4.1 Retest Provision— In case the specimen fails to comply with requirements of the specification, test a specimen in accordance with the following procedure. Give the test specimen three applications of a load sufficient to compress it to 50 % of its thickness before test. Apply the load without shock and at such a rate that the specimen will be compressed approximately 0.05 in. [1.3 mm]/min. After the first and second applications, release the load immediately, and permit the specimen to recover 30 min before the load is again applied. After the third application, release the load immediately and permit the specimen to recover 1 h; then measure the thickness again. Remove the load-transferring apparatus and spherical bearing block from the test specimen during recovery periods between compressions and following the third application of load. Acceptance shall be based on the results of these check tests. Calculate the percentage of recovery as follows:

$$\text{Recovery, \%} = \frac{t_1}{t} \times 100 \quad (3)$$

where:

- t = thickness of the specimen before test and
- t_1 = thickness 1 h after completion of the third application of load.

7.2.5 Compression— Calculate the unit pressure by dividing the maximum load in lbf [N] as determined in 7.2.4 by the area, 16 in.² [0.0104 m²] and record as the unit pressure in psi [kPa].

7.3 Extrusion:

7.3.1 Test Specimens— For this test, use one of the test specimens prepared as described in 6.1 (or one of the self-expanding cork specimens prepared in 6.2). In the case of cork, sponge rubber, bituminous cork, and fiber expansion joint

fillers, make these tests on specimens of the materials as received. If the cork filler fails to meet the requirements of the specifications, make check tests on specimens that have been immersed in water for 24 h and subsequently air-dried for 24 h. Base acceptance on the results of these check tests.

7.3.2 Mounting—Place the test specimen in a suitable steel mold so constructed as to confine the lateral movement of the specimen under compression to one side only, as described in 4.6. Cover the specimen with a ½- by 4- by 4-in. [13- by 102- by 102-mm] metal plate ground to have plane parallel faces, as described in 4.7. Use a simple U-shaped bridge to support above the center of the specimen a dial or other suitable measuring device reading to 0.001 in. [0.03 mm]. Place upon the plate metal cylinder or other device for transferring the load from the moving head of the testing machine around the measuring apparatus to the plate covering the specimen.

7.3.3 Measurement of Thickness—When the specimen has been mounted as described in 7.3.2 and is subjected only to the pressure of the dead weight of the ½- by 4- by 4-in. [13- by 102- by 102-mm] metal plate, determine its thickness by means of the measuring device. When the load-transferring apparatus and spherical bearing block are placed on the test specimen, some compression may result. Consider this reduction in thickness as part of the 50 % reduction in thickness to be applied.

7.3.4 Extrusion—For the determination of the amount of extrusion, give the specimen one application of a load sufficient to compress it to 50 % of its thickness before test. Apply the load without shock at such a rate that the specimen will be compressed approximately 0.05 in. [1.3 mm]/min. Determine the amount of extrusion in inches by measuring the maximum movement of the free edge of the test specimen during the 50 % compression of the specimen. Measure the extrusion by means of a dial micrometer or other suitable device reading to 0.001 in. [0.03 mm].

7.4 Boiling in Hydrochloric Acid:

7.4.1 In the case of cork and self-expanding cork expansion joint fillers only, use one of the test specimens prepared as described in 6.1 (or one of the expanded specimens prepared as described in 6.2). Immerse the specimen in hydrochloric acid (HCl, sp gr 1.19) and boil for 1 h. Examine the test specimen for evidences of disintegration.

7.5 Asphalt Content:

7.5.1 From the test specimens prepared as described in 6.1, cut narrow strips of sufficient length to pack the thimble of the Soxhlet Extractor; approximately 45 g is sufficient. Oven dry the strips at 220 ± 5°F [104 ± 3°C] to constant weight in an open tared weighing dish, then cool in a desiccator. Weigh to the nearest 0.01 g, and subtract tare to obtain initial oven dry weight of specimen.

NOTE 2—Extraction apparatus is similar to Fig. 1 of Methods D 147.

7.5.2 Transfer the test strips to the extraction thimble of known oven dry weight. Extract the asphalt in the Soxhlet Extractor using a chlorinated solvent, such as trichlorethylene, until the extract is essentially clear (color of weak tea).

7.5.3 After extraction, allow excess solvent to drain from the thimble before transferring to an open tared weighing dish and oven dry at 220 ± 5°F [104 ± 3°C] for 1 h. Cool in a

desiccator, then weigh and subtract weighing dish and thimble to obtain the oven dry weight of the extracted fiber.

7.5.4 Calculate the percentage asphalt content by weight on an oven dry basis as follows:

$$\text{Asphalt, \%} = \frac{W^1 - W}{W^1} \times 100 \quad (4)$$

where:

W^1 = initial oven dry weight of test strips and

W = oven dry weight of extracted fiber.

7.6 Water Absorption:

7.6.1 Using a test specimen prepared as described in 6.1, dry the specimen in air, weigh to the nearest 0.1 g, and immerse in water at a temperature of 65 to 75°F [18 to 25°C] in a horizontal position supported from the bottom of the container with 1 in. [25 mm] of water over the specimen for 24 h. Remove the specimen from the water and remove the excess surface water from all sides of the specimen with blotting paper or a paper towel. Quickly weigh the specimen to the nearest 0.1 g. Calculate percent water absorption by volume as follows:

$$\text{Absorption by Volume, \%} = \frac{W_1 - W}{262t} \times 100 \quad (5)$$

where:

W_1 = weight after immersion, g;

W = weight before immersion, g; and

t = thickness, in.

7.6.2 In the event that the metal template or the test specimen or both does not measure to within the tolerances established in 4.7, the length and width of the test specimen must be measured to within 0.01 in. and percent water absorption by volume calculated as follows:

$$\text{Absorption by Volume, \%} = \frac{W_1 - W}{16.41 \times l \times w \times t} \times 100 \quad (6)$$

where:

W_1 = weight after immersion, g;

W = weight before immersion, g;

l = length of specimen, in.;

w = width of specimen, in.; and

t = thickness of specimen, in.

7.7 Density:

7.7.1 Using a specimen prepared as described in Section 6 and, after air drying, weigh to the nearest 0.1 g. For air dry material the specimen shall come to constant weight and moisture in a conditioning atmosphere described in Methods D 1037 for “wood based fiber and particle panel materials,” 65 ± 1 % RH @ 68 ± 6°F. Constant weight is defined as no change greater than 1 % sample weight after 24 h.

7.7.2 For fiber joint only, oven dry the specimen at 220 ± 5°F [104 ± 3°C] for 2 h. After oven drying, cool the specimen to room temperature in a covered desiccator and weigh to nearest 0.1 g.

7.7.3 Calculate the density in lb/ft³, as follows:

$$\text{Density} = \frac{0.238 W}{t} \quad (7)$$

where:

W = weight, g and

t = thickness, in.

7.7.4 In the event that the metal template or the test specimen or both does not measure to within the tolerances established in 4.7, the length and width of the specimen must be measured to within 0.01 in. and density calculated in lb/ft³ as follows:

$$\text{Density} = \frac{3.81 W}{l \times w \times t} \quad (8)$$

where:

W = weight, g;

l = length, in.;

w = width, in.; and

t = thickness, in.

8. Precision and Bias

8.1 Multilaboratory and interlaboratory evaluations of these test procedures are being conducted to establish a precision statement.

9. Keywords

9.1 joint fillers; nonextruding; resilient types

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