



Designation: **D545 – 14 D545 – 19**

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

This standard is issued under the fixed designation D545; 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 These test methods cover the physical properties associated with preformed expansion joint fillers. The test methods include:

Property	Section
Expansion in Boiling Water	7.1
Recovery and Compression	7.2
Extrusion	7.3
Boiling in Hydrochloric Acid	7.4
Asphalt Content	7.5
Water Absorption	7.6
Density	7.7

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

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 The text of this standard references notes and footnotes which provide explanatory material. These notes and footnotes (excluding those in tables and figures) shall not be considered as requirements of the standard.

1.4 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.5 *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.*

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2. Referenced Documents

2.1 *ASTM Standards:*²

[D1037 Test Methods for Evaluating Properties of Wood-Base Fiber and Particle Panel Materials](#)

[D3666 Specification for Minimum Requirements for Agencies Testing and Inspecting Road and Paving Materials](#)

[E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods](#)

[E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method](#)

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 fill 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.

¹ These methods are under the jurisdiction of ASTM Committee D04 on Road and Paving Materials and are the direct responsibility of Subcommittee D04.34 on Preformed Joint Fillers, Sealers and Sealing Systems.

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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.

NOTE 2—The quality of the results produced by this standard are dependent on the competence of the personnel performing the procedure and the capability, calibration, and maintenance of the equipment used. Agencies that meet the criteria of Specification D3666 are generally considered capable of competent and objective testing, sampling, inspection, etc. Users of this standard are cautioned that compliance with Specification D3666 alone does not completely ensure reliable results. Reliable results depend on many factors; following the suggestions of Specification D3666 or some similar acceptable guideline provides a means of evaluating and controlling some of those factors.

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~~ three-sided, open-top box.
- 4.7 *Template*—One steel template 4 by 4 in. (102 by ~~102 mm~~, 102 mm), machined from $\frac{1}{2}$ -in. (~~6.4 mm~~) (12.7 mm) steel plate to fit the extrusion mold. The template shall fit the mold ~~within 0.005 in.~~ 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~~) 2.5 mm) with parallel faces machined from $\frac{1}{2}$ -in. (~~6.4 mm~~) (12.7 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 ± 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 applied without shock at 0.05 in. (1.3 mm) per min.
- 4.10 *Extractor Apparatus*, Soxhlet Extractor with thermostatically controlled heating element.

5. Sampling

- 5.1 One representative sample approximately $2 \text{ ft}^2/1000 \text{ ft}^2$ 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 $4\frac{1}{2}$ by $4\frac{1}{2}$ -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~~ 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.~~ 0.001 in. (0.03 mm). Immerse the specimens in boiling water for 1 h; remove and allow to cool to room temperature for ~~15 min.~~ 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 further 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~~ 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 4½ 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~~ U-shaped 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.

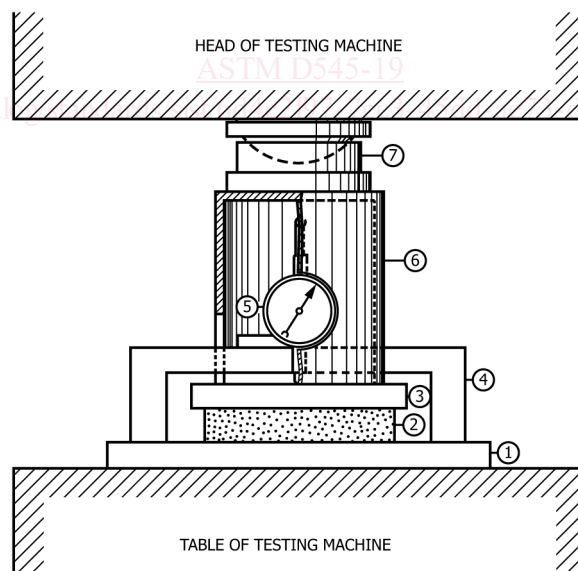
7.2.3 Measurement of Thickness—When the specimen has been mounted as described in 7.2.2 and is subjected only to the pressure of the dead weight of the 4½ by 4½ by ½-in. (114 by 114 by 13-mm) metal plate, determine its thickness by means of the measuring device. When the load-transferring apparatus and 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(1.3 mm) mm)/min./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:

$$\text{Recovery, \%} = \frac{t_1}{t} \times 100 \tag{2}$$

where:

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



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

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

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.~~ 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 $220 \pm 5^\circ\text{F}$ ($104 \pm 3^\circ\text{C}$) 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~~ oven-dry weight of specimen.

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 suitable solvent (see Note 23) until the extract is essentially clear (color of weak tea).

NOTE 3—A “suitable solvent” is any solvent that effectively separates the asphalt. Dichloromethane (methylene chloride) or N-Propyl-Bromide are commonly recommended. The solvent used shall be included in the report.

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 $220 \pm 5^\circ\text{F}$ ($104 \pm 3^\circ\text{C}$) for 1 h. Cool in a desiccator, then weigh to the nearest 0.01 g and subtract weighing dish and thimble to obtain the ~~oven-dry~~ oven-dry weight of the extracted fiber.

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

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