Standard Test Method for
Breaking Load and Calculated Modulus of Rupture of
Preformed Insulation for Pipes\textsuperscript{1}

This standard is issued under the fixed designation C 446; 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 (\(\varepsilon\)) indicates an editorial change since the last revision or reapproval.

\textsuperscript{1} Note—Section 9 was added editorially in September 1993.

1. Scope

1.1 This test method covers the determination of the breaking load and calculated modulus of rupture of preformed thermal insulation for pipes.

1.2 This standard does not purport to address all of the safety problems, 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.

1.3 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are provided for information only.

2. Referenced Documents

2.1 ASTM Standards:

E 4 Practices for Force Verification of Testing Machines\textsuperscript{2}

3. Significance and Use

3.1 This test method is used to determine the resistance to breakage of preformed pipe insulation under transverse loads applied normal to the inside (concave) surface under specified test conditions. The formula assumes that the material being tested is isotropic and that the stress-strain relationships above and below the elastic limit are nearly alike. This test method is not applicable to thermal insulations of certain types in which failure by crushing occurs before failure in transverse bending. The values determined are considered helpful, along with other properties, as a measure of the resistance of the insulation to damage by shipping and handling.

4. Apparatus

4.1 Testing Machine—A properly calibrated testing machine that can be operated at either constant load rates or constant rates of crosshead motion over the range indicated, and in which the error in the load-measuring system shall not exceed \(\pm 1\%\) of maximum load expected to be measured. The load-indicating mechanism shall be essentially free of inertial lag. The accuracy and calibration of the testing machine shall be verified in accordance with Practice E 4. If stiffness or deflection measurements are to be made, then the machine shall be equipped with a deflection-type measuring device. The stiffness of the testing machine shall be such that the total elastic deformation of the system does not exceed 1\% of the total deflection of the test specimen during test, or appropriate corrections shall be made.

4.2 Bearing Edges—Rounded bearing edges, at least 1⁄8 in. (9.5 mm) in diameter. If soft materials are tested, the bearing edges may indent the samples; in this case, bearing edges of larger diameter should be used. The outside bearing edges (or saddles) shall be curved to fit the outside arc of the specimens, and the center bearing edge shall be curved to fit the inside arc of the specimens, so as to maintain full contact with the surfaces of the samples. They shall be at least as long as the respective curved surfaces with which they will be in contact. Different size bearing edges are required for each different inside or outsider diameter to be tested.

5. Test Specimen

5.1 The test specimens shall be quarter-section (90°) pieces, approximately 12 in. (305 mm) in length. They shall be cut from full-size sections or half-sections in such a manner as to preserve the original surfaces as much as possible.

5.2 The specimens shall be dried to constant weight in a vented oven at 215 to 250°F (119 to 139°C).

\textsuperscript{1} This test method is under the jurisdiction of ASTM Committee C-16 on Thermal Insulation and is the direct responsibility of Subcommittee C16.32 on Mechanical Properties.


\textsuperscript{2} Annual Book of ASTM Standards, Vol 03.01.

\textsuperscript{1} Note—If the material is one that may be physically affected by heating at 215 to 250°F (119 to 139°C), the specimens shall be dried in a desiccator at 120 to 140°F (67 to 78°C).

6. Procedure

6.1 Test at least four specimens.

6.2 Place the outside bearing edges so as to provide a span of 10 in. (254 mm) between their centers; a jig is advisable to hold them. Place a test specimen on the two outside bearing edges and apply the load at mid-span, with the center bearing edge in complete contact with and perpendicular to the inside, or concave, surface. The outside, or convex, surface will thus be in tension.

6.3 Testing Speed—Set the testing machine so that the rate
of deflection at the midpoint does not exceed 0.5 in./min.

6.4 Apply the load until definite failure occurs (as indicated by a fall-off in the load), and record the maximum load in pounds as indicated by the testing machine.

6.5 Measure the outside arc of each test specimen once to the nearest 0.03 in. (0.76 mm), and the thickness twice to the nearest 0.01 in. (0.25 mm), once on each side of the break.

7. Calculation

7.1 Calculate the modulus of rupture as follows:

\[
S = \frac{0.25 \times W \times l}{0.3214(R^2 - r^2)(R^2 - r^2) - 0.2829(r^2 - r^2)}
\]

(1)

where:
- \( S \) = modulus of rupture, psi,
- \( W \) = load (maximum) at which the specimen failed, lbf,
- \( l \) = distance between the supports, in.,
- \( R \) = outside radius of specimen = outside arc of specimen \( \times \frac{4}{\pi} \), in., and
- \( r \) = inside radius of specimen = \( R \) minus the average thickness, in.

8. Report

8.1 The report shall include the following, when specified:

- Average value of the breaking load, \( W \), in pounds-force,
- Average value of the modulus of rupture, \( S \), in pounds-force per square inch.

9. Precision and Bias

9.1 Since this test method is destructive to each specimen, repeatability is not measurable on a single specimen. A statement of precision and bias is entirely dependent upon a large body of statistical test data, but such data are not available at this time. Test results that can be used for statistical evaluation of this test method are solicited by ASTM Subcommittee C16.32.

10. Keywords

10.1 breaking load; breaking strength/tenacity; flexural strength; modulus of rupture (MOR); preformed pipe insulation