Designation: C203 − 05a (Reapproved 2017)

Standard Test Methods for Breaking Load and Flexural Properties of Block-Type Thermal Insulation[1]

This standard is issued under the fixed designation C203; 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 determination of the breaking load and calculated flexural strength of a rectangular cross section of a preformed block-type thermal insulation tested as a simple beam. It is also applicable to cellular plastics. Two test methods are described as follows:

1.1.1 *Test Method I*—A loading system utilizing center loading on a simply supported beam, supported at both ends.

1.1.2 *Test Method II*—A loading system utilizing two symmetric load points equally spaced from their adjacent support points at each end with a distance between load points of one half of the support span.

1.2 Either test method is capable of being used with the four procedures that follow:

1.2.1 *Procedure A*—Designed principally for materials that break at comparatively small deflections.

1.2.2 *Procedure B*—Designed particularly for those materials that undergo large deflections during testing.

1.2.3 *Procedure C*—Designed for measuring at a constant stress rate, using a CRL (constant rate of loading) machine. Used for breaking load measurements only.

1.2.4 *Procedure D*—Designed for measurements at a constant crosshead speed, using either a CRT (constant rate of traverse) or CRE (constant rate of extension) machine. Used for breaking load measurements using a fixed crosshead speed machine.

1.3 Comparative tests are capable of being run according to either method or procedure, provided that the method or procedure is found satisfactory for the material being tested.

1.4 These test methods are purposely general in order to accommodate the widely varying industry practices. It is important that the user consult the appropriate materials specification for any specific detailed requirements regarding these test methods.

1.5 The values stated in SI units are to be regarded as the standard. The values given in parentheses are provided for information only.

1.6 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.* For specific precautionary statements, see Section 11

1.7 *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.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C133 Test Methods for Cold Crushing Strength and Modulus of Rupture of Refractories
C168 Terminology Relating to Thermal Insulation
C390 Practice for Sampling and Acceptance of Thermal Insulation Lots
C870 Practice for Conditioning of Thermal Insulating Materials
D76 Specification for Tensile Testing Machines for Textiles
E4 Practices for Force Verification of Testing Machines

3. Terminology

3.1 Terminology C168 shall be considered applied to the terms used in this method.

4. Summary of Test Methods

4.1 A bar of rectangular cross section is tested in flexure as a beam as follows:

[1] These test methods are under the jurisdiction of ASTM Committee C16 on Thermal Insulation and are the direct responsibility of Subcommittee C16.32 on Mechanical Properties.

Current edition approved Sept. 1, 2017. Published December 2017. Originally approved in 1945. Last previous edition approved 2012 as C203 – 05a (2012). DOI: 10.1520/C0203-05AR17.

[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.

4.1.1 *Test Method I*—The bar rests on two supports and is loaded by means of a loading fitting or piece midway between the supports (see Fig. 1).

4.1.2 *Test Method II*—The bar rests on two supports and is loaded at the two quarter points (by means of two loading fittings), each an equal distance from the adjacent support point. The distance between the loading fittings is one half of the support span (see Fig. 2).

4.2 The specimen is deflected until rupture occurs, unless the materials specification indicates termination at a particular maximum strain level.

NOTE 1—One criteria used is to limit the strain to 5 %. If failure does not occur at 5 % strain, the strain rate is increased and the test repeated on a new specimen.

4.3 Procedures A and B allow for testing at two different strain rates. Procedure C specifies a stress rate. Procedure D specifies a rate of extension or traverse.

4.3.1 Procedure A specifies a strain rate of 0.01 in./in. (mm/mm) that is useful for testing insulations that are very stiff or break at quite low deflections.

4.3.2 Procedure B specifies a strain rate of 0.1 in./in. (mm/mm) which is useful for testing insulations that are relatively flexible or break at higher deflections.

4.3.3 Procedure C specifies a stress rate of 550 psi (3.79 MPa)/min except as applicable in the materials specification.

4.3.4 Procedure D specifies a CRE machine with a fixed crosshead speed, or a CRT machine with a movable load clamp, such as the Scott tester. Because the strain rate is a function of specimen geometry, this procedure does not give a constant strain rate for specimens of different thicknesses tested on the same loading fixture.

5. Significance and Use

5.1 These test methods are to be used to determine the resistance of some types of preformed block insulation when transverse loads are normally applied to the surface. Values are measured at the maximum load or breaking point under specified conditions or specimen size, span between supports, and rate of load application. The equations used are based on the assumption that the materials are uniform and presume that the stress-strain characteristics below the elastic limit are linearly elastic. These assumptions are not strictly applicable to thermal insulations of certain types in which crushing occurs before failure is obtained in transverse bending; however, depending upon the accuracy required, these procedures are capable of providing acceptable results.

5.2 Test Method I is especially useful when testing only for the modulus of rupture or the breaking load. This information is useful for quality control inspection and qualification for specification purposes.

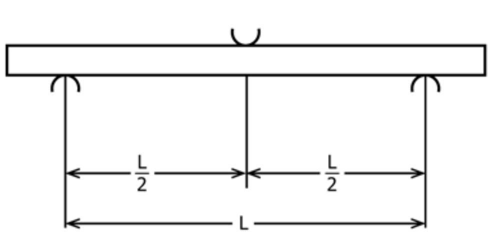

FIG. 1 Loading System for Test Method I

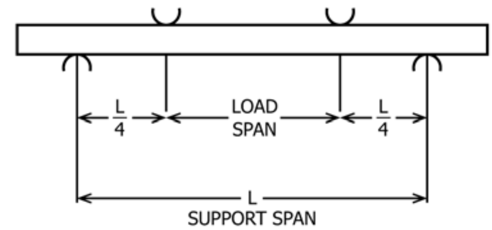

FIG. 2 Loading System for Test Method II

5.3 Test Method II is useful in determining the elastic modulus in bending as well as the flexural strength. Flexural properties determined by these test methods are also useful for quality control and specification purposes.

5.4 The basic differences between the two test methods is in the location of the maximum bending moment, maximum axial fiber (flexural or tensile) stresses, and the resolved stress state in terms of shear stress and tensile/compression stress. The maximum axial fiber stresses occur on a line under the loading fitting in Test Method I and over the area between the loading fittings in Test Method II. Test Method I has a high shear stress component in the direction of loading, perpendicular to the axial fiber stress. Sufficient resolved shear stress is capable of producing failure by a shear mode rather than a simple tension/flexural failure. There is no comparable shear component in the central region between the loading fittings in Test Method II. Test Method II simulates a uniformly loaded beam in terms of equivalent stresses at the center of the specimen.

5.5 Flexural properties are capable of varing with specimen span-to-thickness ratio, temperature, atmospheric conditions, and the difference in rate of straining specified in Procedures A and B. In comparing results it is important that all parameters be equivalent. Increases in the strain rate typically result in increased strengths and in the elastic modulus.

6. Apparatus

6.1 *Testing Machine*—A properly calibrated testing machine that is capable of being 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 ±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 E4. 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.

6.2 *Bearing Edges*—The loading fittings and supports shall have cylindrical surfaces. In order to avoid excessive indentation, or failure due to stress concentration directly under the loading fitting or fittings, the diameter of these bearing edges shall be 1¼ ± ¼ in. (32 ± 6 mm). The bearing cylinders