Designation: ~~D1621 – 10~~ D1621 – 16

Standard Test Method for Compressive Properties of Rigid Cellular Plastics[1]

This standard is issued under the fixed designation D1621; 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 describes a procedure for determining the compressive properties of rigid cellular materials, particularly expanded plastics.

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

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 determine the applicability of regulatory limitations prior to use.*

NOTE 1—This test method and ISO 844 are technically equivalent.

2. Referenced Documents

2.1 *ASTM Standards:*[2]
D618 Practice for Conditioning Plastics for Testing
E4 Practices for Force Verification of Testing Machines
E83 Practice for Verification and Classification of Extensometer Systems
E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method
2.2 *ISO Standard:*
ISO 844 Cellular Plastics—Compression Test of Rigid Materials[3]

3. Terminology

3.1 *Definitions:*

3.1.1 *compliance*—the displacement difference between test machine drive system displacement values and actual specimen displacement.

3.1.2 *compliance correction*—an analytical method of modifying test instrument displacement values to eliminate the amount of that measurement attributed to test instrument compliance.

3.1.3 *compressive deformation*—the decrease in length produced in the gage length of the test specimen by a compressive load expressed in units of length.

3.1.4 *compressive strain*—the dimensionless ratio of compressive deformation to the gage length of the test specimen or the change in length per unit of original length along the longitudinal axis.

3.1.5 *compressive strength*—the stress at the yield point if a yield point occurs before 10 % deformation (as in Fig. 1a) or, in the absence of such a yield point, the stress at 10 % deformation (as in Fig. 1b).

3.1.6 *compressive stress (nominal)*—the compressive load per unit area of minimum original cross section within the gage boundaries, carried by the test specimen at any given moment, expressed in force per unit area.

3.1.7 *compressive stress-strain diagram*—a diagram in which values of compressive stress are plotted as ordinates against corresponding values of compressive strain as abscissas.

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[1] This test method is under the jurisdiction of ASTM Committee D20 on Plastics and is the direct responsibility of Subcommittee D20.22 on Cellular Materials - Plastics and Elastomers.

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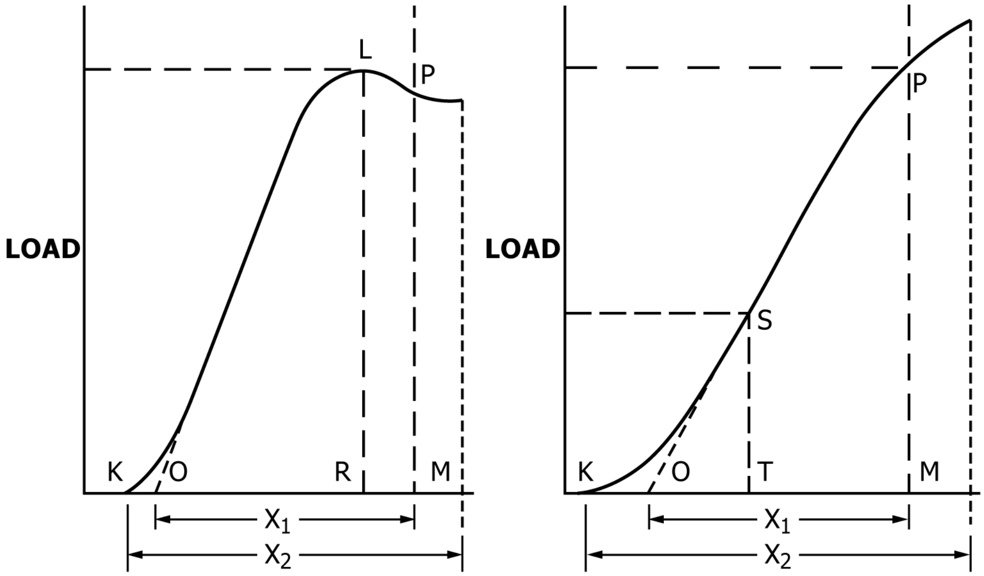
[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

***A Summary of Changes section appears at the end of this standard**



X_1 = 10 % CORE DEFORMATION
X_2 = DEFLECTION (APPROXIMATELY 13 %)

FIG. 1 a Compressive Strength (See 3.1.5 and Section 9) **FIG. 1 b Compressive Strength (See 3.1.5 and Section 9)**

3.1.8 *compressive yield point*—the first point on the stress-strain diagram at which an increase in strain occurs without an increase in stress.

3.1.9 *deflectometer*—a device used to sense the compressive deflection of the specimen by direct measurement of the distance between the compression platens.

3.1.10 *displacement*—compression platen movement after the platens contact the specimen, expressed in millimetres or inches.

3.1.11 *gage length*—the initial measured thickness of the test specimen expressed in units of length.

3.1.12 *modulus of elasticity*—the ratio of stress (nominal) to corresponding strain below the proportional limit of a material expressed in force per unit area based on the minimum initial cross-sectional area.

3.1.13 *proportional limit*—the greatest stress that a material is capable of sustaining without any deviation from proportionality of stress-to-strain (Hooke's law) expressed in force per unit area.

4. Significance and Use

4.1 This test method provides information regarding the behavior of cellular materials under compressive loads. Test data is obtained, and from a complete load-deformation curve it is possible to compute the compressive stress at any load (such as compressive stress at proportional-limit load or compressive strength at maximum load) and to compute the effective modulus of elasticity.

4.2 Compression tests provide a standard method of obtaining data for research and development, quality control, acceptance or rejection under specifications, and special purposes. The tests cannot be considered significant for engineering design in applications differing widely from the load - time scale of the standard test. Such applications require additional tests such as impact, creep, and fatigue.

4.3 Before proceeding with this test method, reference shall be made to the specification of the material being tested. Any test specimen preparation, conditioning, dimensions, or testing parameters, or a combination thereof, covered in the materials specification shall take precedence over those mentioned in this test method. If there are no material specifications, then the default conditions apply.

5. Apparatus

5.1 *Testing Machine*—A testing instrument that includes both a stationary and movable member and includes a drive system for imparting to the movable member (crosshead), a uniform, controlled velocity with respect to the stationary member (base). The testing machine shall also include the following:

5.1.1 *Load Measurement System*—A load measurement system capable of accurately recording the compressive load imparted to the test specimen. The system shall be indicate the load with an accuracy of ±1 % of the measured value or better. The accuracy of the load measurement system shall be verified in accordance with Practices E4.

5.2 *Compression Platens*—Two flat plates, one attached to the stationary base of the testing instrument and the other attached to the moving crosshead to deliver the load to the test specimen. These plates shall be larger than the specimen loading surface to ensure that the specimen loading is uniform. It is recommended that one platen incorporate a spherical seating mechanism to compensate for non-parallelism in the specimen's loading surfaces or non-parallelism in the base and crosshead of the testing instrument.

5.3 *Displacement Measurement System*—A displacement measurement system capable of accurately recording the compressive deformation of the test specimen during testing to an accuracy of ±1 % of the measured value or better. This measurement is made through use of the test machine crosshead drive system or using a direct measurement of compression platen displacement.

5.3.1 *Direct Compression Platen Displacement*—This system shall employ a deflectometer that directly reads the distant between the upper and lower compression platens. The accuracy of the displacement measurement transducer shall be verified in accordance with Practices E83 and shall be classified as a Class C or better.

5.3.2 *Test Machine Crosshead Drive System*—This system shall employ the position output from the crosshead drive system as a indicator of compression platen displacement. This method is only appropriate when it is demonstrated that the effects of drive system compliance result in displacement errors of less than 1 % of the measurement or if appropriate compliance correction methods are employed to reduce the measurement error to less than 1 %.

5.3.2.1 *Determining Drive System Compliance*—Testing instrument drive systems always exhibit a certain level of compliance that is characterized by a variance between the reported crosshead displacement and the displacement actually imparted to the specimen. This variance is a function of load frame stiffness, drive system wind-up, load cell compliance and fixture compliance. This compliance can be measured then, if determined to be significant and empirically subtracted from test data to improve test accuracy. The procedure to determine compliance follows:

(1) Configure the test system to match the actual test configuration.

(2) Position the two compression platens very close to each other simulating a zero thickness specimen in place.

(3) Start the crosshead moving at 12.5 mm (0.5 in.)/min in the compression direction recording crosshead displacement and the corresponding load values.

(4) Increase load to a point exceeding the highest load expected during specimen testing. Stop the crosshead and return to the pre-test location.

(5) The recorded load-deflection curve, starting when the compression platens contact one another, is defined as test system compliance

5.3.2.2 *Performing Compliance Correction*—Using the load-deflection curve created in 5.3.2.1, measure the system compliance at each given load value. On each specimen test curve at each given load value, subtract the system compliance from each recorded displacement value. This will be the new load-deflection curve for use in calculations starting in Section 9.

5.4 *Micrometer Dial ~~Gage,~~Gauge,* caliper, or steel rule, suitable for measuring dimensions of the specimens to ±1 % of the measured values.

6. Test Specimen

6.1 The test specimen shall be square or circular in cross section with a minimum of 25.8 cm^2 (4 $in.^2$) and maximum of 232 cm^2 (36 $in.^2$) in area. The minimum height shall be 25.4 mm (1 in.) and the maximum height shall be no greater than the width or diameter of the specimen. Care should be taken so that the loaded ends of the specimen are parallel to each other and perpendicular to the sides.

NOTE 2—Cellular plastics are not ideal materials, and the compressive modulus may appear significantly different, depending on the test conditions, particularly the test thickness. All data that are to be compared should be obtained using common test conditions.

6.2 All surfaces of the specimen shall be free from large visible flaws or imperfections.

6.3 If the material is suspected to be anisotropic, the direction of the compressive loading must be specified relative to the suspected direction of anisotropy.

6.4 A minimum of five specimens shall be tested for each sample. Specimens that fail at some obvious flaw should be discarded and retests made, unless such flaws constitute a variable the effect of which it is desired to study.

7. Conditioning

7.1 *Conditioning*—Condition the test specimens at 23 ± 2°C (73.4 ± 3.6°F) and 50 ± 10 % relative humidity for not less than 40 h prior to test in accordance with Procedure A of Practice D618, unless otherwise specified in the contract or relevant material specification. In cases of disagreement, the tolerances shall be ±1°C (±1.8°F) and ±5 % relative humidity.

7.2 *Test Conditions*—Conduct tests in the standard laboratory atmosphere of 23 ± 2°C (73.4 ± 3.6°F) and 50 ± 10 % relative humidity, unless otherwise specified. In cases of disagreement, the tolerances shall be ±1°C (±1.8°F) and ±5 % relative humidity.

8. Procedure

8.1 Measure the dimensions of the specimen to a precision of ±1 % of the measurement as follows: