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Standard Test Method for Compressive Properties of Plastic Lumber and Shapes[1]

This standard is issued under the fixed designation D 6108; 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.

1. Scope*

1.1 This test method covers the determination of the mechanical properties of plastic lumber and shapes, when the entire cross-section is loaded in compression at relatively low uniform rates of straining or loading. Test specimens in the "as-manufactured" form are employed. As such, this is a test method for evaluating the properties of plastic lumber or shapes as a product and not a material property test method.

1.2 Plastic lumber and plastic shapes are currently made predominantly with recycled plastics. However, this test method would also be applicable to similar manufactured plastic products made from virgin resins, or where the product is non-homogenous in the cross-section.

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

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

NOTE 1—There is no similar or equivalent ISO standard.

2. Referenced Documents

2.1 *ASTM Standards:*

D 618 Practice for Conditioning Plastics for Testing[2]

D 883 Terminology Relating to Plastics[2]

D 4000 Classification System for Specifying Plastic Materials[3]

D 5033 Guide for the Development of Standards Relating to the Proper Use of Recycled Plastics[4]

D 5947 Test Methods for Physical Dimensions of Solid Plastics Specimens[4]

D 6111 Test Method for Bulk Density and Specific Gravity of Plastic Lumber and Shapes by Displacement[4]

E 4 Practices for Load Verification of Testing Machines[5]

E 83 Practice for Verification and Classification of Extensometers[5]

E 691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method[6]

3. Terminology

3.1 *Definitions:*

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

3.1.2 *compressive strain*—the ratio of compressive deformation to the gage length of the test specimen, that is, the change in length per unit of original gage length along the longitudinal axis. It is expressed as a dimensionless ratio.

3.1.3 *compressive strength*—the maximum compressive stress (nominal) carried by a test specimen during a compression test. It may or may not be the compressive stress (nominal) carried by the specimen at the moment of rupture.

3.1.4 *compressive stress (nominal)*—the compressive load per unit area of minimum (or effective as calculated in accordance with Test Method D 6111) original cross section within the gage boundaries, carried by the test specimen at any given moment. It is expressed in force per unit area.

3.1.4.1 *Discussion*—The expression of compressive stress in terms of the minimum original cross section is almost universally used. Under some circumstances the compressive stress has been expressed per unit of prevailing cross section. This stress is called the "true compressive stress".

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

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

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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 D20.20 on Plastic Products (Section D20.20.01).

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[2] *Annual Book of ASTM Standards*, Vol 08.01.

[3] *Annual Book of ASTM Standards*, Vol 08.02

[4] *Annual Book of ASTM Standards*, Vol 08.03.

[5] *Annual Book of ASTM Standards*, Vol 03.01.

[6] *Annual Book of ASTM Standards*, Vol 14.02.

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

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3.1.7 *modulus of elasticity*—the ratio of compressive stress (nominal) to corresponding compressive strain below the proportional limit of a material. It is expressed in force per unit area based on the effective/average initial cross-sectional area.

3.1.8 *percent compressive strain*—the compressive deformation of a test specimen expressed as a percent of the original gage length.

3.1.9 *plastic lumber*, *n*—a manufactured product composed of more than 50 weight percent resin, and in which the product generally is rectangular in cross-section and typically supplied in board and dimensional lumber sizes, may be filled or unfilled, and may be composed of single or multiple resin blends.

3.1.10 *plastic shape*, *n*—a manufactured product composed of more than 50 weight percent resin, and in which the product generally is not rectangular in cross-section, may be filled or unfilled, and may be composed of single or multiple resin blends.

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

3.1.12 *resin*, *n*—a solid or pseudosolid organic material often of high molecular weight, which exhibits a tendency to flow when subjected to stress, usually has a softening or melting range, and usually fractures conchoidally. (See Terminology D 883.)

3.1.12.1 *Discussion*—In a broad sense, the term is used to designate any polymer that is a basic material for plastics.

3.1.13 *secant modulus*—the ratio of the compressive stress (nominal) to the corresponding value of compressive strain on the stress-strain diagram at a specified value of strain, typically one percent strain (0.01 mm/mm) for plastic lumber. It is expressed in force per unit area based on the effective initial cross-sectional area.

3.1.14 *stress at a given strain*—the stress on the stress-strain curve at a specified value of strain.

3.1.14.1 *Discussion*—The stress at a given strain should not be taken as the ultimate strength at failure. Typically a strain value of 3 % or 0.03 mm/mm is used for plastic lumber. The ultimate strength, or the maximum value of stress on the stress-strain diagram, can be higher for plastic lumber occurring at values of strain much greater than 3 %.

3.2 Additional definition of terms applying to this test method appear in Terminology D 883 and Guide D 5033.

4. Significance and Use

4.1 Compression tests provide information about the compressive properties of plastic lumber and shapes when these products are used under conditions approximating those under which the tests are made. For many materials, there may be a specification that requires the use of this test method, but with some procedural modifications that take precedence when adhering to the specification. Therefore, it is advisable to refer to that material specification before using this test method. Table 1 in Classification D 4000 lists the ASTM materials standards that currently exist.

4.2 Compressive properties include modulus of elasticity, secant modulus, compressive strength, and stress at a given strain. In the case of a material that fails in compression by a shattering fracture, the compressive strength has a very definite value. In the case of a material that does not fail in compression by a shattering fracture nor exhibits a compressive yield point, the compressive strength is an arbitrary one depending upon the degree of distortion that is regarded as indicating complete failure. Many plastic lumber materials will not exhibit a true yield point. Compressive strength can have no real meaning in such cases. For plastic lumber, the stress at a given strain of 3 % (0.03 in./in. [mm/mm]) is typically used.

4.3 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.

5. Apparatus

5.1 *Testing Machine*— Any suitable testing machine capable of control of constant-rate-of-crosshead movement and comprising essentially the following:

5.1.1 *Drive Mechanism*— A drive mechanism for imparting to the cross-head movable member, a uniform, controlled rate of movement with respect to the base (fixed member), with this cross-head rate to be regulated as specified in Section 9.

5.1.2 *Load Indicator*— A load-indicating mechanism capable of showing the total compressive load carried by the test specimen. The mechanism shall be essentially free from inertia-lag at the specified rate of testing and shall indicate the load with an accuracy of ±1 % of the maximum indicated value of the test (load). The accuracy of the testing machine shall be verified at least once a year in accordance with Practices E 4.

5.2 *Compressometer*— A suitable instrument for determining the distance between two fixed points on the test specimen at any time during the test. It is desirable that this instrument automatically record this distance (or any change in it) as a function of the load on the test specimen. The instrument shall be essentially free of inertia-lag at the specified rate of loading and shall conform to the requirements for a Class C extensometer as defined in Practice E 83.

5.2.1 The requirements for extensometers cited herein apply to compressometers as well.

5.2.2 Compression platen movement may be used to determine compressive displacements of test samples.

5.3 *Compression Platens*—A compression platen for applying the load to the test specimen. Parallel platens shall be used to apply the load to an unconfined type specimen. One of the compression platens shall be self aligning in order that the load may be applied evenly over the face of the specimen.

5.4 *Micrometers*— Suitable micrometers, reading to 0.01 in. for measuring the width, thickness, and length of the specimens.

6. Test Specimens

6.1 Test specimens for determining compressive properties of plastic lumber and shapes shall be cut from the "as manufactured" profile. Great care shall be taken in cutting and

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