Designation: D 6109 – 97ε1

Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastic Lumber[1]

This standard is issued under the fixed designation D 6109; 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.

ε[1] NOTE—Editorially corrected 1.1 in April 2002.

1. Scope

1.1 These test methods cover the determination of flexural properties of plastic lumber with rectangular or square cross-sections. The test specimens are whole "as manufactured" pieces without any altering or machining of surfaces beyond cutting to length. As such, this is a test method for evaluating the properties of plastic lumber as a product and not a material property test method. Flexural strength cannot be determined for those products that do not break or that do not fail in the extreme outer fiber.

1.2 *Test Method A*—designed principally for products in the flat or "plank" position.

1.3 *Test Method B*—designed principally for those materials in the edgewise or "joist" position.

1.4 Plastic lumber is currently made predominately with recycled plastics where the product is non-homogeneous in the cross-section. However, this test method would also be applicable to similar manufactured plastic products made from virgin resins or other plastic composite materials.

1.5 The values stated in inch–pound units are to be regarded as the standard. The values given in parentheses are 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 and health practices and determine the applicability of regulator limitations prior to use.*

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

2. Referenced Documents

2.1 *ASTM Standards:*

D 198 Methods of Static Tests of Lumber in Structural Sizes[2]

D 618 Practice for Conditioning Plastics for Testing[3]

D 883 Terminology Relating to Plastics[3]

D 4000 Classification System for Specifying Plastic Materials[4]

D 5033 Guide for the Development of Standards Relating to the Proper Use of Recycled Plastics[5]

D 5947 Test Methods for Physical Dimensions of Solid Plastics Specimens[5]

E 4 Practices for Force Verification of Testing Machines[6]

3. Terminology

3.1 *Definitions:* Definitions of terms applying to these test methods appear in Terminology D 883D 883 and Guide D 5033D 5033.

3.1.1 *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.

3.1.2 *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.

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

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

4. Summary of Test Method

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

4.1.1 The bar rests on two supports and is loaded at two points (by means of two loading noses), each an equal distance

[1] These test methods are under the jurisdiction of ASTM Committee D-20 on Plastics and are 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 04.10.

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

[4] *Annual Book of ASTM Standards*, Vol 08.02.

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

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

from the adjacent support point. The distance between the loading noses (that is, the load span) is one-third of the support span (see Fig. 1).

4.1.2 The specimen is deflected until rupture occurs in the outer fibers or until a maximum outer fiber strain of 3 % is reached, whichever occurs first.

5. Significance and Use

5.1 Flexural properties determined by this test method are especially useful for research and development, quality control, acceptance or rejection under specifications, and special purposes.

5.2 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. It is therefore advisable to refer to that material specification before using these test methods. Table 1 in Classification D 4000D 4000 lists the ASTM materials standards that currently exist.

5.3 Flexural properties may vary with specimen depth, temperature, atmospheric conditions, and the difference in rate of straining specified in Test Methods A and B.

6. Apparatus

6.1 *Testing Machine*—A properly calibrated testing machine that is capable of operation at a constant rate of motion of the movable head and has the accuracy of ±1 % of maximum load expected to be measured. It shall be equipped with a deflection 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 testing, or appropriate corrections shall be made. The load indication mechanism shall be essentially free from inertial lag at the crosshead rate used. The accuracy of the testing machine shall be verified in accordance with Practice E 4E 4.

6.2 *Loading Noses and Supports*—The loading noses and supports shall have cylindrical surfaces. In order to avoid excessive indentation, of the failure due to stress concentration directly under the loading noses, the radius or noses and supports shall be at least 0.5 in. (12.7 mm) for all specimens. If significant indentation or compressive failure occurs or is observed at the point where the loading noses contact the specimen, then the radius of the loading noses should be increased up to 1.5 times the specimen depth. The arc of the loading nose in contact with the specimen shall be sufficiently large to prevent contact of the specimen with the sides of the noses (see Fig. 2).

NOTE 2—Test data have shown that the loading noses and support dimensions can influence the flexural modulus values. Dimensions of loading noses and supports must be specified in the test report.

6.3 *Lateral Supports*—Specimens tested in the edgewise or "joist" position having a depth-to-width ratio greater than two are subject to lateral instability during loading, especially if the specimen breaks. For safety, lateral supports are needed while testing such specimens. Lateral support apparatus shall be provided at least at points located about half-way between the reaction and the load point. Additional supports may be used as required. Each support shall allow vertical movement without frictional restraint but shall restrict lateral deflection (See Fig. 3). Test Method D 198D 198 provides further examples of lateral support apparatus.

7. Test Specimens

7.1 The specimens shall be full size as manufactured, then cut to length for testing. The original outside surfaces shall be unaltered. The support span to depth ratio shall be nominally 16:1.

7.2 For Test Method A, flatwise or "plank" tests, the depth of the specimen shall be the thickness, or smaller dimension, of the material. For Test Method B, edgewise or "joist" tests the width becomes the smaller dimension and depth the larger. For all tests, the support span shall be 16 (tolerance +4 and −2) times the depth of the beam. The specimen shall be long enough to allow for overhanging on each end of at least 10 % of the support span. Overhang shall be sufficient to prevent the specimen from slipping through the supports.

8. Number of Test Specimens

8.1 Five specimens shall be tested for each sample.

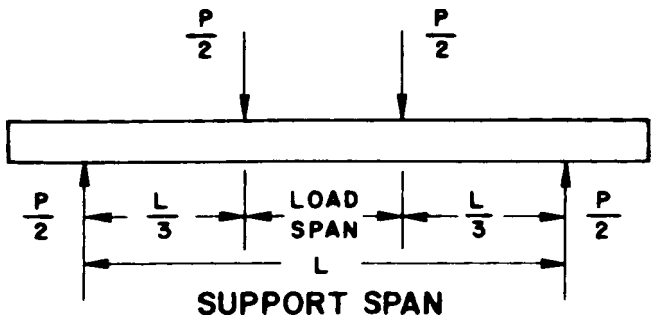
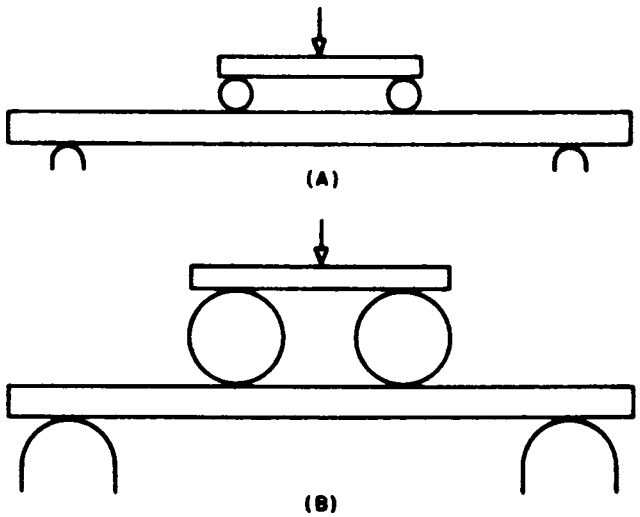


FIG. 1 Loading Diagram



NOTE 1—(*A*) = minimum radius = 12.7 mm; (*B*) = maximum radius = 1.5 times the specimen depth.

FIG. 2 Four Point Loading and Support Noses at Minimum and Maximum Radius

FIG. 3 Example of Lateral Support

9. Conditioning

9.1 *Specimen Conditioning*—Condition the test specimens at 73.4 ± 3.6°F (23 ± 2°C) and 50 ± 5 % relative humidity for not less than 40 h prior to testing in accordance with Procedure A of Practice D 618D 618 for those tests where conditioning is required. In cases of disagreement, the tolerances shall be ±1.8°F (±1°C) and ±2 % relative humidity.

9.2 *Test Conditions*—Conduct the tests in the Standard Laboratory Atmosphere of 73.4 ± 3.6°F (23 ± 2°C) and 50 ± 5 % relative humidity, unless otherwise specified in the test methods or in this specification. In cases of disagreement, the tolerances shall be ±1.8°F (±1°C) and ±2 % relative humidity.

10. Procedure

10.1 *Test Method A*:

10.1.1 *Flatwise or "plank" Testing*:

10.1.2 Use an untested specimen for each measurement. Measure the width of the specimen to a precision of 1 % of the measured dimensions at several points along the product's length and record the average value. Measure the depth of the specimen at several points and record the average value (see Test Methods D D 59475947 for additional information).

10.1.3 Determine the support span to be used as described in Section 7 and set the support span to within 1 % of the determined value.

10.1.4 Calculate the rate of crosshead motion as follows, and set the machine as near as possible to that calculated rate for a load span of one-third of the support span:

$$R = 0.185ZL^2/d \quad (1)$$

where:

R = rate of crosshead motion, in./min (mm/min),
L = support span, in. (mm),
d = depth of the beam, in. (mm), and
Z = rate of straining of the outer fibers, in./in./min (mm/mm/min). Z shall be equal to 0.01.

In no case shall the actual crosshead rate differ from that calculated from Eq 1, by more than ± 50 %.

10.1.5 Align the loading noses and supports so that the axes of the cylindrical surfaces are parallel and the load span is one-third of the support span. This parallelism may be checked by means of a plate containing parallel grooves into which the loading noses and supports will fit when properly aligned. Center the specimen on the supports, with the long axis of the specimen perpendicular to the loading noses and supports. The loading nose assembly shall be of the type which will not rotate.

10.1.6 Apply the load to the specimen at the specified crosshead rate, and take simultaneous load-deflection data. Measure deflection at the common center of the spans. Make appropriate corrections for indentation in the specimens and