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.

Designation: D6109 – 24

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

This standard is issued under the fixed designation D6109; 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 These test methods are suitable for determining the flexural properties for any solid or hollow manufactured plastic lumber product of square, rectangular, round, or other geometric cross section that shows viscoelastic behavior. 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.

NOTE 1—This test method was developed for application to plastic lumber materials, but it is generic enough that it would be equally applicable to other plastic composite materials, including wood-plastic composite materials.

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

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

1.4 Plastic lumber currently is produced using several different plastic manufacturing processes. These processes utilize a number of diverse plastic resin material systems that include fillers, fiber reinforcements, and other chemical additives. The test methods are applicable to plastic lumber products where the plastic resin is the continuous phase, regardless of its manufacturing process, type or weight percentage of plastic resin utilized, type or weight percentage of fillers utilized, type or weight percentage of reinforcements utilized, and type or weight percentage of other chemical additives.

1.4.1 Alternative to a single resin material system, diverse and multiple combinations of both virgin and recycled thermoplastic material systems are permitted in the manufacture of plastic lumber products.

1.4.2 Diverse types and combinations of inorganic and organic filler systems are permitted in the manufacturing of plastic lumber products. Inorganic fillers include such materials as talc, mica, silica, wollastonite, calcium carbonate, and so forth. Organic fillers include lignocellulosic materials made or derived from wood, wood flour, flax shive, rice hulls, wheat straw, and combinations thereof.

1.4.3 Fiber reinforcements used in plastic lumber include manufactured materials such as fiberglass (chopped or continuous), carbon, aramid and other polymerics; or lignocellulosic-based fibers such as flax, jute, kenaf, and hemp.

1.4.4 A wide variety of chemical additives are added to plastic lumber formulations to serve numerous different purposes. Examples include colorants, chemical foaming agents, ultraviolet stabilizers, flame retardants, lubricants, anti-static products, biocides, heat stabilizers, and coupling agents

1.5 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

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.*

NOTE 2—There is no known ISO equivalent to this standard.

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]

D618 Practice for Conditioning Plastics for Testing

[1] These test methods are under the jurisdiction of ASTM Committee D20 on Plastics and are the direct responsibility of Subcommittee D20.20 on Plastic Lumber (Section D20.20.01).

Current edition approved Feb. 1, 2024. Published February 2024. Originally approved in 1997. Last previous edition approved in 2019 as D6109 – 19. DOI: 10.1520/D6109-24.

[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.

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

Copyright © ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959. United States

Documents
Document Sharing Hub
Full document details: ASTM D6109-24

D883 Terminology Relating to Plastics
D2915 Practice for Sampling and Data-Analysis for Structural Wood and Wood-Based Products
D5033 Guide for Development of ASTM Standards Relating to Recycling and Use of Recycled Plastics (Withdrawn 2007)[3]
D5947 Test Methods for Physical Dimensions of Solid Plastics Specimens
E4 Practices for Force Calibration and Verification of Testing Machines
E456 Terminology Relating to Quality and Statistics
E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method
E2935 Practice for Evaluating Equivalence of Two Testing Processes

3. Terminology

3.1 *Definitions:*

3.1.1 Definitions of terms applying to these test methods appear in Terminology D883 and Guide D5033. For terms relating to precision and bias and associated issues, the terms used in this test method are in accordance with the definitions in Terminology E456.

3.1.2 *plastic lumber, n*—a manufactured product made primarily from plastic materials (filled or unfilled), typically used as a building material for purposes similar to those of traditional lumber, which is usually rectangular in cross-section. (Terminology D883)

3.1.2.1 *Discussion*—Plastic lumber is typically supplied in sizes similar to those of traditional lumber board, timber and dimension lumber; however the tolerances for plastic lumber and for traditional lumber are not necessarily the same. (Terminology D883)

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. (Terminology D883)

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 either in a flat, or "plank," mode (Method A) or edgewise, or "joist," mode (Method B) as follows:

4.1.1 The beam rests on two supports and is loaded at two points (by means of two loading noses), each an equal distance 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; use of other distances for the load spans are addressed in Appendix X1).

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.

[3] The last approved version of this historical standard is referenced on www.astm.org.

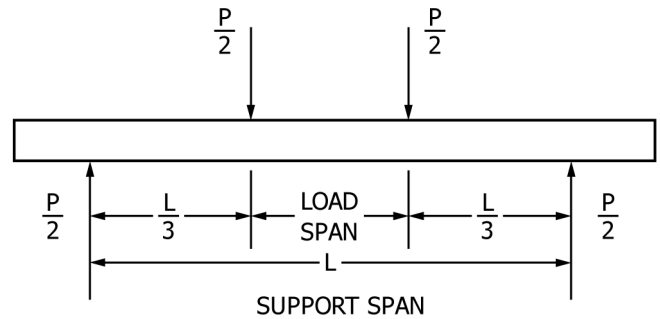


FIG. 1 Loading Diagram

5. Significance and Use

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

5.2 Specimen depth, temperature, atmospheric conditions, and the difference in rate of straining specified in Test Methods A and B are capable of influencing flexural property results.

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 E4.

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 shall be increased up to 1.5 times the specimen depth (see Fig. 2).

NOTE 3—Test data have shown that the loading noses and support dimensions are capable of influencing the flexural modulus values. Dimensions of loading noses and supports must be specified in the test report.

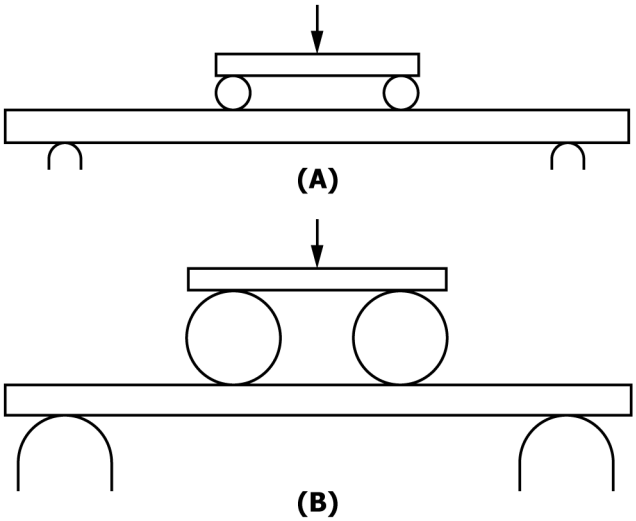
7. Test Specimens

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 product. For Test Method B, edgewise or "joist" tests the width becomes the smaller dimension and depth the larger for

AVA Documents
Document Sharing Hub

Full document details: ASTM D6109-24



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

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.

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 D618 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 referenced test methods or in these test methods. 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 D5947 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 ±10 %.

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. Check parallelism 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. Perform the necessary toe compensation (see Annex A1) to correct for seating and indentation of the specimen and deflections in the machine. Stress-strain curves shall be plotted to determine the flexural yield strength, modulus of elasticity and secant modulus at 1 % strain.

10.1.7 If no break has occurred in a specimen by the time the maximum strain in the outer fibers has reached 0.03 in./in. (mm/mm), discontinue the test (see Note 4 and Note 5). The deflection at which this strain occurs shall be calculated by letting r equal 0.03 in./in. (mm/mm) as follows for a load span of one-third of the support span:

$$D = 0.21\, rL^2/d \quad (2)$$

where:

D = midspan deflection, in. (mm),
r = strain, in./in. (mm/mm), and
d = depth of the beam, in. (mm).

NOTE 4—For some products the increase in strain rate provided under Test Method B is capable of inducing the specimen to yield or rupture, or both, within the required 3 % strain limit.

NOTE 5—If the product does not fracture at a maximum of 3 % strain, these test methods do not reveal true flexural strength.

10.2 *Test Method B:*

10.2.1 *Edgewise or "Joist" Testing:*

10.2.2 Follow procedures of Test Method A, except that Z, the rate of strain of the outer fibers, shall nominally be in the range of 0.002 and 0.003 in./in./min (mm/mm/min).

10.2.3 *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 stability and safety during the test, 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 shall be used as required to provide

AVA Documents
Document Sharing Hub

Full document details: ASTM D6109-24