Designation: D198 – 21

Standard Test Methods of Static Tests of Lumber in Structural Sizes[1]

This standard is issued under the fixed designation D198; 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.

INTRODUCTION

Numerous evaluations of structural members of sawn lumber have been conducted in accordance with Test Methods D198. While the importance of continued use of a satisfactory standard should not be underestimated, the original standard (1927) was designed primarily for sawn lumber material, such as bridge stringers and joists. With the advent of structural glued laminated (glulam) timbers, structural composite lumber, prefabricated wood I-joists, and even reinforced and prestressed timbers, a procedure adaptable to a wider variety of wood structural members was required and Test Methods D198 has been continuously updated to reflect modern usage.

The present standard provides a means to evaluate the flexure, compression, tension, and torsion strength and stiffness of lumber and wood-based products in structural sizes. A flexural test to evaluate the shear stiffness is also provided. In general, the goal of the D198 test methods is to provide a reliable and repeatable means to conduct laboratory tests to evaluate the mechanical performance of wood-based products. While many of the properties tested using these methods may also be evaluated using the field procedures of Test Methods D4761, the more detailed D198 test methods are intended to establish practices that permit correlation of results from different sources through the use of more uniform procedures. The D198 test methods are intended for use in scientific studies, development of design values, quality assurance, or other investigations where a more accurate test method is desired. Provision is made for varying the procedure to account for special problems.

1. Scope

1.1 These test methods cover the evaluation of lumber and wood-based products in structural sizes by various testing procedures.

1.2 The test methods appear in the following order:

	Sections
Flexure	4 – 11
Compression (Short Specimen)	13 – 20
Compression (Long Specimen)	21 – 28
Tension	29 – 36
Torsion	37 – 44
Shear Modulus	45 – 52

1.3 Notations and symbols relating to the various testing procedures are given in Appendix X1.

1.4 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.

1.5 *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.*

1.6 *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]

D9 Terminology Relating to Wood and Wood-Based Products

D1165 Nomenclature of Commercial Hardwoods and Softwoods

D2395 Test Methods for Density and Specific Gravity (Relative Density) of Wood and Wood-Based Materials

[1] These test methods are under the jurisdiction of ASTM Committee D07 on Wood and are the direct responsibility of Subcommittee D07.01 on Fundamental Test Methods and Properties.

Current edition approved June 1, 2021. Published July 2021. Originally approved in 1924. Last previous edition approved in 2015 as D198–15. DOI: 10.1520/D0198-21.

[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.

D2915 Practice for Sampling and Data-Analysis for Structural Wood and Wood-Based Products
D3737 Practice for Establishing Allowable Properties for Structural Glued Laminated Timber (Glulam)
D4442 Test Methods for Direct Moisture Content Measurement of Wood and Wood-Based Materials
D4761 Test Methods for Mechanical Properties of Lumber and Wood-Based Structural Materials
D7438 Practice for Field Calibration and Application of Hand-Held Moisture Meters
E4 Practices for Force Verification of Testing Machines
E6 Terminology Relating to Methods of Mechanical Testing
E83 Practice for Verification and Classification of Extensometer Systems
E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods
E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method
E2309 Practices for Verification of Displacement Measuring Systems and Devices Used in Material Testing Machines

3. Terminology

3.1 *Definitions*—See Terminology E6, Terminology D9, and Nomenclature D1165.

3.2 *Definitions:*Definitions of Terms Specific to This Standard:

3.2.1 *composite wood member*—a laminar construction comprising a combination of wood and other simple or complex materials assembled and intimately fixed in relation to each other so as to use the properties of each to attain specific structural advantage for the whole assembly.

3.2.2 *depth (d)*—the dimension of the flexure specimen or shear modulus specimen that is perpendicular to the span and parallel to the direction in which the load is applied (Fig. 1).

3.2.3 *shear span*—two times the distance between a reaction and the nearest load point for a symmetrically loaded flexure specimen (Fig. 1).

3.2.4 *shear span-depth ratio*—the numerical ratio of shear span divided by depth of a flexure specimen.

3.2.5 *span (ℓ)*—the total distance between reactions on which a flexure specimen or shear modulus specimen is supported to accommodate a transverse load (Fig. 1).

3.2.6 *span-depth ratio (ℓ/d)*—the numerical ratio of total span divided by depth of a flexure specimen or shear modulus specimen.

3.2.7 *structural member*—sawn lumber, glulam, structural composite lumber, prefabricated wood I-joists, or other similar product for which strength or stiffness, or both, are primary criteria for the intended application and which usually are used in full length and in cross-sectional sizes greater than nominal 2 by 2 in. (38 by 38 mm).

FLEXURE

4. Scope

4.1 This test method covers the determination of the flexural properties of structural members. This test method is intended primarily for members with rectangular cross sections but is also applicable to members with round and irregular shapes, such as round posts, pre-fabricated wood I-joists, or other special sections.

5. Summary of Test Method

5.1 The flexure specimen is subjected to a bending moment by supporting it near its ends, at locations called reactions, and applying transverse loads symmetrically imposed between these reactions. The specimen is deflected at a prescribed rate, and coordinated observations of loads and deflections are made until rupture occurs.

6. Significance and Use

6.1 The flexural properties established by this test method provide:

6.1.1 Data for use in development of grading rules and specifications;

6.1.2 Data for use in development of design values for structural members;

6.1.3 Data on the influence of imperfections on mechanical properties of structural members;

6.1.4 Data on strength properties of different species or grades in various structural sizes;

6.1.5 Data for use in checking existing equations or hypotheses relating to the structural behavior;

6.1.6 Data on the effects of chemical or environmental conditions on mechanical properties;

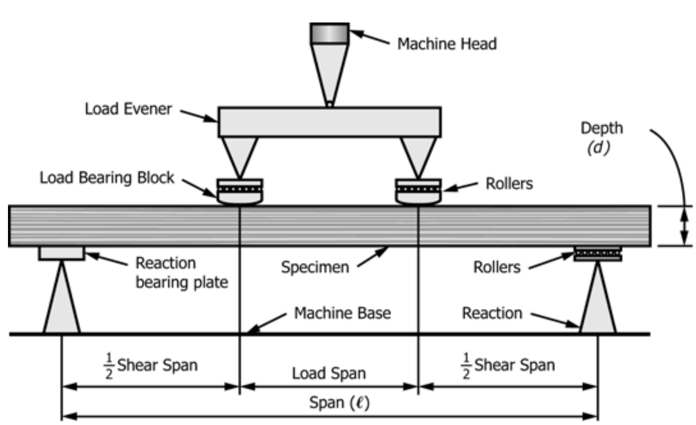

FIG. 1 Flexure Test Method—Example of Two-Point Loading

6.1.7 Data on effects of fabrication variables such as depth, taper, notches, or type of end joint in laminations; and

6.1.8 Data on relationships between mechanical and physical properties.

6.2 Procedures are described here in sufficient detail to permit duplication in different laboratories so that comparisons of results from different sources will be valid. Where special circumstances require deviation from some details of these procedures, these deviations shall be carefully described in the report (see Section 11).

7. Apparatus

7.1 *Testing Machine*—A device that provides (*1*) a rigid frame to support the specimen yet permit its deflection without restraint, (*2*) a loading head through which the force is applied without high-stress concentrations in the specimen, and (*3*) a force-measuring device that is calibrated to ensure accuracy in accordance with Practices E4.

7.2 *Support Apparatus*—Devices that provide support of the specimen at the specified span.

7.2.1 *Reaction Bearing Plates*—The specimen shall be supported by metal bearing plates to prevent damage to the specimen at the point of contact with the reaction support (Fig. 1). The plates shall be of sufficient length, thickness, and width to provide a firm bearing surface and ensure a uniform bearing stress across the width of the specimen.

7.2.2 *Reaction Supports*—The bearing plates shall be supported by devices that provide unrestricted longitudinal deformation and rotation of the specimen at the reactions due to loading. Provisions shall be made to restrict horizontal translation of the specimen (see 7.3.1 and Appendix X5).

7.2.3 *Reaction Bearing Alignment*—Provisions shall be made at the reaction supports to allow for initial twist in the length of the specimen. If the bearing surfaces of the specimen at its reactions are not parallel, then the specimen shall be shimmed or the individual bearing plates shall be rotated about an axis parallel to the span to provide full bearing across the width of the specimen. Supports with lateral self-alignment are normally used (Fig. 2).

7.2.4 *Lateral Support*—Specimens that have a depth-to-width ratio (*d/b*) of three or greater are subject to out-of-plane lateral instability during loading and require lateral support. Lateral support shall be provided at points located about halfway between a reaction and a load point. Additional supports shall be permitted as required to prevent lateral-torsional buckling. Each support shall allow vertical movement without frictional restraint but shall restrict lateral displacement (Fig. 3).

7.3 *Load Apparatus*—Devices that transfer load from the testing machine at designated points on the specimen. Provisions shall be made to prevent eccentric loading of the load measuring device (see Appendix X5).

7.3.1 *Load Bearing Blocks*—The load shall be applied through bearing blocks (Fig. 1), which are of sufficient thickness and extending entirely across the specimen width to eliminate high-stress concentrations at places of contact between the specimen and bearing blocks. Load shall be applied to the blocks in such a manner that the blocks shall be permitted to rotate about an axis perpendicular to the span (Fig. 4). To prevent specimen deflection without restraint in case of two-point loading, metal bearing plates and rollers shall be used in conjunction with one or both load-bearing blocks, depending on the reaction support conditions (see Appendix X5). Provisions such as rotatable bearings or shims shall be made to ensure full contact between the specimen and the loading blocks. The size and shape of these loading blocks, plates, and rollers may vary with the size and shape of the specimen, as well as for the reaction bearing plates and supports. For rectangular structural products, the loading surface of the blocks shall have a radius of curvature equal to two to four times the specimen depth. Specimens having circular or irregular cross-sections shall have bearing blocks that distribute the load uniformly to the bearing surface and permit unrestrained deflections.

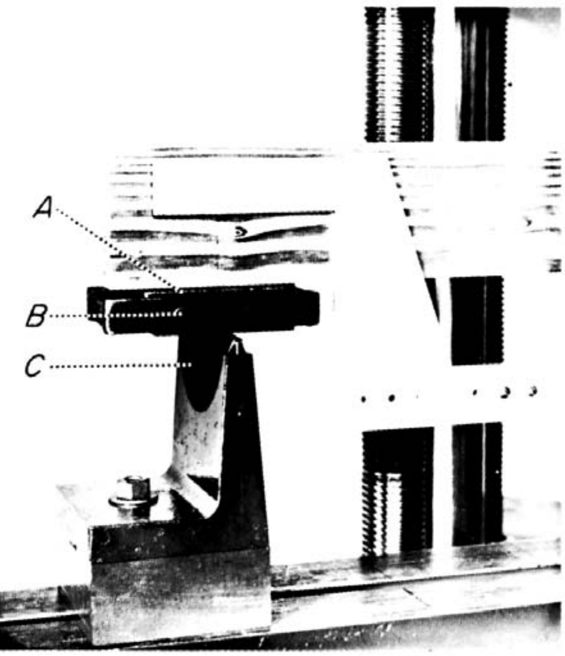

FIG. 2 Example of Bearing Plate (A), Rollers (B), and Reaction-Alignment-Rocker (C), for Small Flexure Specimens

7.3.2 *Load Points*—Location of load points relative to the reactions depends on the purpose of testing and shall be recorded (see Appendix X5).

7.3.2.1 *Two-Point Loading*—The total load on the specimen shall be applied equally at two points equidistant from the reactions. The two load points will normally be at a distance from their reaction equal to one third of the span ($\ell/3$) (third-point loading), but other distances shall be permitted for special purposes.

7.3.2.2 *Center-Point Loading*—A single load shall be applied at mid-span.

7.3.2.3 For evaluation of shear properties, center-point loading or two-point loading shall be used (see Appendix X5).

7.4 *Deflection-Measuring Apparatus:*

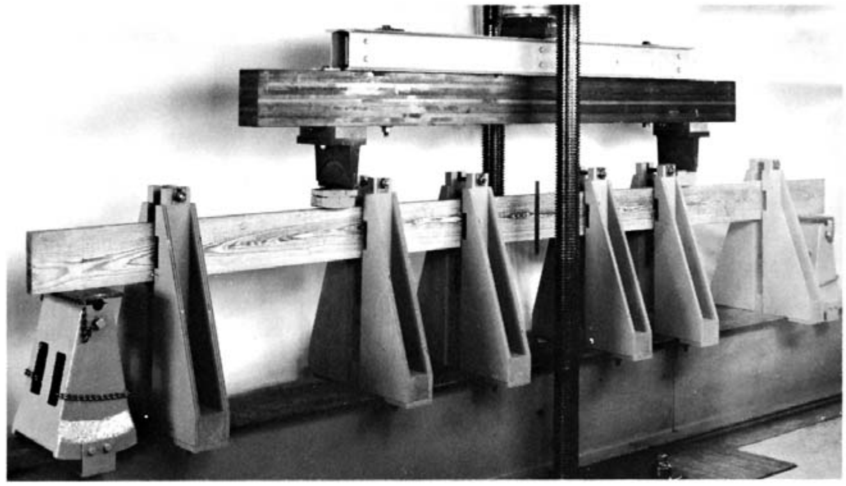

FIG. 3 Example of Lateral Support for Long, Deep Flexure Specimens

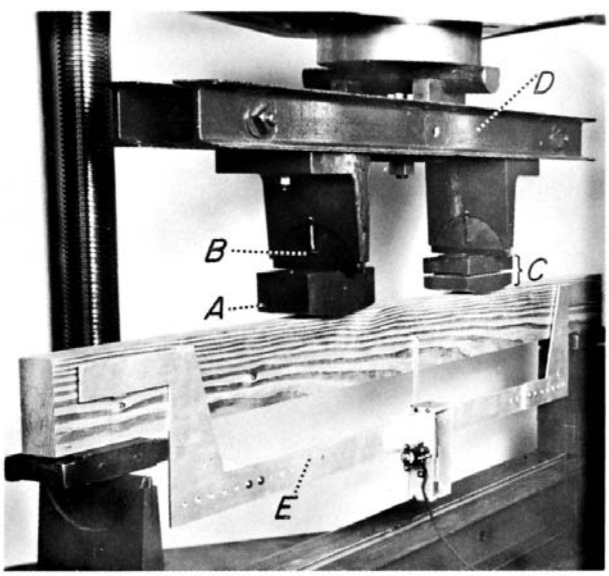

FIG. 4 Example of Curved Loading Block (A), Load-Alignment Rocker (B), Roller-Curved Loading Block (C), Load Evener (D), and Deflection-Measuring Apparatus (E)

7.4.1 *General*—For modulus of elasticity calculations, devices shall be provided by which the deflection of the neutral axis of the specimen at the center of the span is measured with respect to a straight line joining two reference points equidistant from the reactions and on the neutral axis of the specimen.

7.4.1.1 The apparent modulus of elasticity (E_{app}) shall be calculated using the full-span deflection (Δ). The reference points for the full-span deflection measurements shall be positioned such that a line perpendicular to the neutral axis at the location of the reference point, passes through the support's center of rotation.

7.4.1.2 The true or shear-free modulus of elasticity (E_{sf}) shall be calculated using the shear-free deflection. The reference points for the shear-free deflection measurements shall be positioned at cross-sections free of shear and stress concentrations (see Appendix X5).

NOTE 1—The apparent modulus of elasticity (E_{app}) may be converted to the shear-free modulus of elasticity (E_{sf}) by calculation, assuming that the shear modulus (G) is known. See Appendix X2.

7.4.2 *Wire Deflectometer*—A wire stretched taut between two nails, smooth dowels, or other rounded fixtures attached to the neutral axis of the specimen directly above the reactions and extending across a scale attached at the neutral axis of the specimen at mid-span shall be permitted to read deflections with a telescope or reading glass to magnify the area where the wire crosses the scale. When a reading glass is used, a reflective surface placed adjacent to the scale will help to avoid parallax.

7.4.3 *Yoke Deflectometer*—A satisfactory device commonly used to measure deflection of the center of the specimen with respect to any point along the neutral axis consists of a lightweight U-shaped yoke suspended between nails, smooth dowels, or other rounded fixtures attached to the specimen at its neutral axis. An electronic displacement gauge, dial micrometer, or other suitable measurement device attached to the center of the yoke shall be used to measure vertical displacement at mid-span relative to the specimen's neutral axis (Fig. 4).

7.4.4 *Alternative Deflectometers*—Deflectometers that do not conform to the general requirements of 7.4.1 shall be permitted provided the mean deflection measurements are not significantly different from those devices conforming to 7.4.1. The equivalency of such devices to deflectometers, such as those described in 7.4.2 or 7.4.3, shall be documented and demonstrated by comparison testing.

NOTE 2—Where possible, equivalency testing should be undertaken in the same type of product and stiffness range for which the device will be used. Issues that should be considered in the equivalency testing include the effect of crushing at and in the vicinity of the load and reaction points, twist in the specimen, and natural variation in properties within a specimen.