Designation: ~~D198 – 21a~~ D198 – 22

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] 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 ~~Aug. 1, 2021~~Aug. 1, 2022. Published ~~August 2021~~August 2022. Originally approved in 1924. Last previous edition approved in 2021 as D198 – ~~21.~~21a. DOI: ~~10.1520/D0198-21A.~~10.1520/D0198-22.

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
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 Calibration and 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.

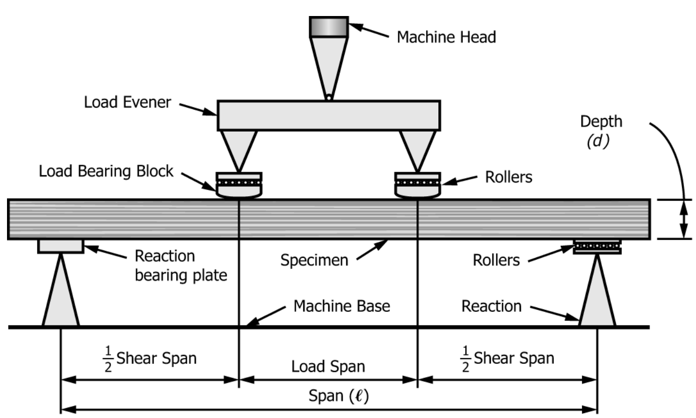

FIG. 1 Flexure Test Method—Example of Two-Point Loading

[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.

3.2.2 *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 until failure occurs. Coordinated observations of loads and deflections are made.

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;

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

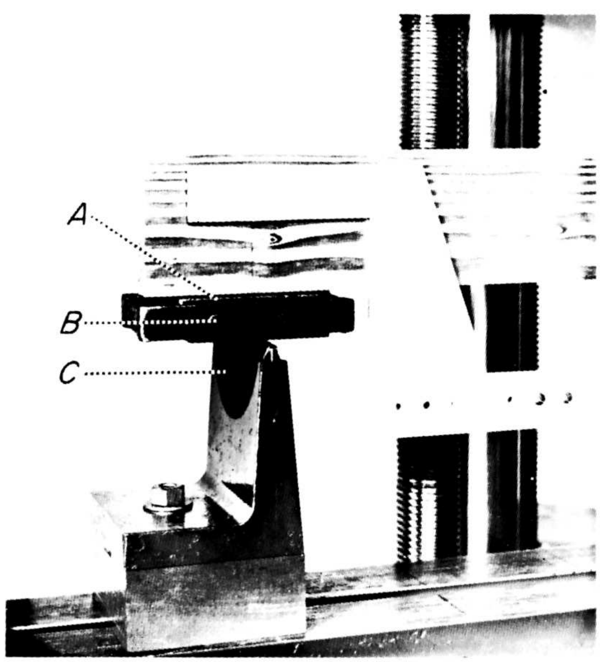

FIG. 2 Example of Bearing Plate (A), Rollers (B), and Reaction-Alignment-Rocker (C), for Small Flexure Specimens

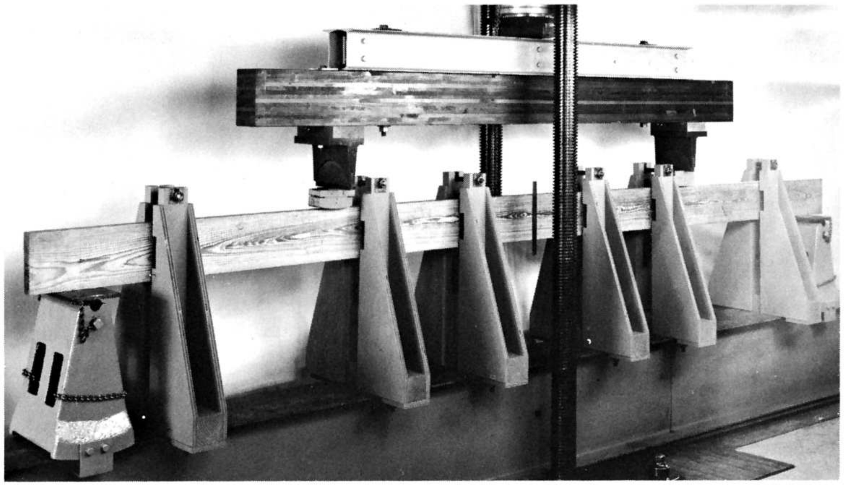

FIG. 3 Example of Lateral Support for Long, Deep Flexure Specimens

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.

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.

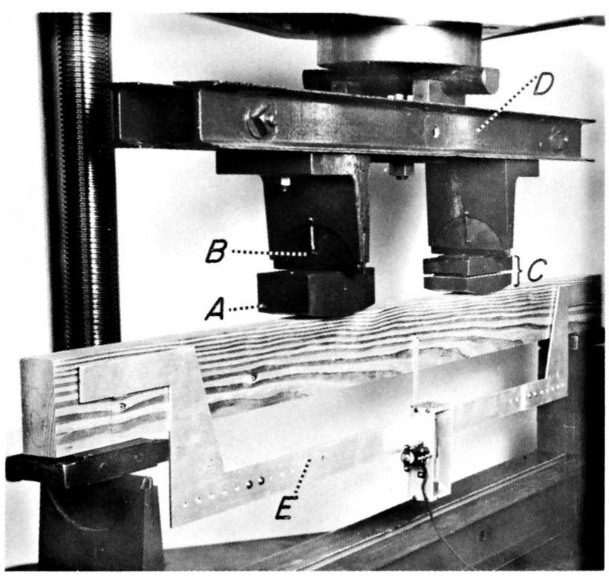

FIG. 4 Example of Curved Loading Block (A), Load-Alignment Rocker (B), Roller-Curved Loading Block (C), Load Evener (D), and Deflection-Measuring Apparatus (E)

7.3.2.2 *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:*

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.

7.4.5 *Accuracy*—The deflection measurement devices and recording system shall be capable of at least a Class B rating when evaluated in accordance with Practice E2309.

8. Flexure Specimen

8.1 *Material*—The flexure specimen shall consist of a structural member.

8.2 *Identification*—Material or materials of the specimen shall be identified as fully as possible by including the origin or source of supply, species, and history of drying and conditioning, chemical treatment, fabrication, and other pertinent physical or mechanical details that potentially affect the strength or stiffness. Details of this information shall depend on the material or materials in the structural member. For example, wood beams or joists would be identified by the character of the wood, that is, species, source, and so forth, whereas structural composite lumber would be identified by the grade, species, and source of the material (that is, product manufacturer, manufacturing facility, etc.).

8.3 *Specimen Measurements*—The weight and dimensions (length and cross-section) of the specimen shall be measured before the test to three significant figures. Sufficient measurements of the cross section shall be made along the length to describe the width and depth of rectangular specimens and to determine the critical section or sections of non-uniform (or non-prismatic) specimens. The physical characteristics of the specimen as described by its density or specific gravity shall be permitted to be determined in accordance with Test Methods D2395.

8.4 *Specimen Description*—The inherent strength-reducing characteristics or intentional modifications of the composition of the specimen shall be fully described by recording the size and location of such factors including, but not limited to, knots, checks, and reinforcements. Size and location of intentional modifications such as placement of laminations, glued joints, and reinforcements shall be recorded during the fabrication process or prior to testing. Where required by the test objectives for materials with discrete strength-reducing characteristics or intentional modifications, sketch or photographic records shall be made of each face and the ends. These sketches or photographs shall show the size, location, and type of strength-reducing characteristics or intentional modifications, including: reinforcements, glued joints, slope of grain, knots, distribution of sapwood and heartwood, location of pitch pockets, direction of annual rings, and such abstract factors as crook, bow, cup, twist, which might affect the flexural strength. Where required by the test objectives, the surface features of each specimen shall be described in sufficient detail to deduce the extent of the strength-reducing characteristics within the cross section.

8.5 *Rules for Determination of Specimen Length*—The cross-sectional dimensions of structural products usually have established sizes, depending upon the manufacturing process and intended use, so that no modification of these dimensions is involved. The length, however, will be established by the type of data desired (see Appendix X5). The span length is determined from knowledge of specimen depth, the distance between load points, as well as the type and orientation of material in the specimen. The total specimen length includes the span (measured from center to center of the reaction supports) and the length of the overhangs (measured from the center of the reaction supports to the ends of the specimen). Sufficient length shall be provided so that the specimen can accommodate the bearing plates and rollers and will not slip off the reactions during test.

8.5.1 For the evaluation of flexural strength, the overhang beyond the span shall be minimized, as the measured flexural capacity is influenced by the length of the overhang. The reaction bearing plates shall be at least long enough to prevent bearing failures. The specimen overhang beyond the test span shall not extend by more than four times the member depth. If longer overhangs are necessary to satisfy the test objectives, the length of overhang shall be reported, and the calculated bending strength shall be reduced to account for the weight of the overhangs. The original bending strength, the overhang-adjusted bending strength, and the method of adjustment shall be reported.

8.5.2 For evaluation of shear properties, the overhang beyond the span shall be minimized, as the shear capacity is influenced by the length of the overhang. The reaction bearing plates shall be the minimum length necessary to prevent bearing failures. The specimen shall not extend beyond the end of the reaction plates (Fig. X5.3 in Appendix X5) unless longer overhangs are required to simulate a specific design condition.

9. Procedure

9.1 *Conditioning*—Unless otherwise indicated in the research program or material specification, condition the specimen to constant weight so it is in moisture equilibrium under the desired environmental conditions. Approximate moisture contents with moisture meters or measure more accurately by weights of samples in accordance with Test Methods D4442.

9.2 *Test Setup*—Determine the size of the specimen, the span, and the shear span in accordance with 7.3.2 and 8.5. Locate the flexure specimen symmetrically on its supports with load bearing and reaction bearing blocks as described in 7.2 – 7.4. The specimen shall be adequately supported laterally in accordance with 7.2.4. Set apparatus for measuring deflections in place (see 7.4). Full contact shall be attained between support bearings, loading blocks, and the specimen surface.

9.3 *Speed of Testing*—The loading shall progress at a constant deformation rate such that the average time to maximum load for the test series shall be at least 4 min. It is permissible to initially test a few random specimens from a series at an alternate rate as the test rate is refined. Otherwise, the selected rate shall be held constant for the test series.

9.4 *Load-Deflection Curves:*

9.4.1 Obtain load-deflection data with apparatus described in 7.4.1. When the objective of the deflection measurement is only to determine the specimen stiffness or modulus of elasticity, it shall be permitted to remove the deflection-measuring apparatus at any point after either the proportional limit or 40 % of the expected average maximum load is achieved. Note the load at first failure, at the maximum load, and at points of sudden change in specimen behavior. If the deflection measurement is continued to failure, then it shall also be recorded at the same points. Continue loading until complete failure or an arbitrary terminal load has been reached.

9.4.2 If an additional deflection-measuring apparatus is provided to measure the shear-free deflection (Δ_{sf}) over a second distance (ℓ_{sf}) in accordance with 7.4.1.2, such load-deflection data shall be obtained until either the proportional limit or 40 % of the expected average maximum load are achieved.

9.5 *Record of Failures*—Describe failures in detail as to type, manner, and order of occurrence, and position in the specimen. Record descriptions of the failures and relate them to specimen drawings or photographs referred to in 8.4. Also record notations as the order of their occurrence on such references. Hold the section of the specimen containing the failure for examination and reference until analysis of the data has been completed.

9.6 *Moisture Content Determination*—Following the test, measure the moisture content of the specimen at a location away from the end and as close to the failure zone as practical in accordance with the procedures outlined in Test Methods D4442. Alternatively, the moisture content for a wood specimen shall be permitted to be determined using a calibrated moisture meter according to Standard Practice D7438. The number of moisture content samples shall be determined using Practice D7438 guidelines, with consideration of the expected moisture content variability, and any related requirements in the referenced product standards.

10. Calculation

10.1 Compute physical and mechanical properties and their appropriate adjustments for the specimen in accordance with the relationships in Appendix X2.

11. Report

11.1 Report the following information:

11.1.1 Complete identification of the specimen, including species, origin, shape and form, fabrication procedure, type and location of imperfections or reinforcements, and pertinent physical or chemical characteristics relating to the quality of the material,

11.1.2 History of seasoning and conditioning,

11.1.3 Loading conditions to portray the load and support mechanics, including type of equipment, lateral supports, if used, the location of load points relative to the reactions, the size of load bearing blocks, reaction bearing plates, clear distances between load block and reaction plate and between load blocks, and the size of overhangs, if present,

11.1.4 Deflection apparatus,

11.1.5 Depth and width of the specimen or pertinent cross-sectional dimensions,

11.1.6 Span length and shear span distance,

11.1.7 Rate of load application,

11.1.8 Computed physical and mechanical properties, including specific gravity or density (as applicable) and moisture content, flexural strength, stress at proportional limit, modulus of elasticity, calculation methods (Note 3), and a statistical measure of variability of these values,

NOTE 3—Appendix X2 provides acceptable formulae and guidance for determining the flexural properties.

11.1.9 Description of failure, and

11.1.10 Details of any deviations from the prescribed or recommended methods as outlined in the standard.

12. Precision and Bias

12.1 *Interlaboratory Test Program*—An interlaboratory study (ILS) was conducted in 2006–2007 by sixteen laboratories in the United States and Canada in accordance with Practice E691.[3] The scope of this study was limited to the determination of the apparent modulus of elasticity of three different 2 × 4 nominal sized products tested both edgewise and flatwise. The deflection of each flexure specimen's neutral axis at the mid-span was measured with a yoke according to 7.4. Five specimens of each product were tested in a round-robin fashion in each laboratory, with four test results obtained for each specimen and test orientation. The resulting precision indexes are shown in Table 1. For further discussion, see Appendix X5.4.

12.2 The terms of repeatability and reproducibility are used as specified in Practice E177.

12.3 *Bias*—The bias is not determined because the apparent modulus of elasticity is defined in terms of this method, which is generally accepted as a reference (Note 4).

NOTE 4—Use of this method does not necessarily eliminate laboratory bias or ensure a level of consistency necessary for establishing reference values. The users are encouraged to participate in relevant interlaboratory studies (that is, an ILS involving sizes and types of product similar to those regularly tested by the laboratory) to provide evidence that their implementation of the Test Method provides levels of repeatability and reproducibility at least comparable to those shown in Table 1. See also X5.4.2 and X5.4.3.

COMPRESSION PARALLEL TO GRAIN (SHORT SPECIMEN, NO LATERAL SUPPORT, $\ell/r < 17$)

13. Scope

13.1 This test method covers the determination of the compressive properties of specimens taken from structural members when such a specimen has a slenderness ratio (length to least radius of gyration) of less than 17. The method is intended primarily for structural members with rectangular cross sections, but is also applicable to irregularly shaped studs, braces, chords, round poles, or special sections.

TABLE 1 Test Materials, Configurations, and Precision Indexes[A]

Product	Test Orientation	Width × Depth $b \times d$ in. (mm)	Span Test ℓ in. (mm)	Average Apparent Modulus of Elasticity E_{app} psi × 10^6 (GPa)	Repeatability Coefficient of Variation CV_r	Reproducibility Coefficient of Variation CV_R	Repeatability Limits		Reproducibility Limits	
							$2CV_r$	$d2CV_r$	$2CV_R$	$d2CV_R$
A	Edgewise	1.5 × 3.5 (38 × 89)	63.0 (1600)	2.17 (14.9)	1.4 %	2.0 %	2.7 %	3.8 %	4.0 %	5.6 %
	Flatwise	3.5 × 1.5 (89 × 38)	31.5 (800)	2.18 (15.0)	1.4 %	3.3 %	2.7 %	3.9 %	6.5 %	9.2 %
B	Edgewise	1.5 × 3.5 (38 × 89)	63.0 (1600)	1.49 (10.3)	1.0 %	2.1 %	2.0 %	2.8 %	4.2 %	5.9 %
	Flatwise	3.5 × 1.5 (89 × 38)	31.5 (800)	1.54 (10.6)	1.3 %	2.7 %	2.6 %	3.6 %	5.3 %	7.5 %
C	Edgewise	1.5 × 3.5 (38 × 89)	63.0 (1600)	2.35 (16.2)	1.3 %	2.0 %	2.5 %	3.5 %	3.9 %	5.5 %
	Flatwise	3.5 × 1.5 (89 × 38)	31.5 (800)	2.78 (19.2)	1.5 %	4.3 %	2.9 %	4.2 %	8.3 %	11.8 %
All Data	Edgewise	1.5 × 3.5 (38 × 89)	63.0 (1600)	. . .	1.2 %	2.1 %	2.4 %	3.4 %	4.0 %	5.7 %
	Flatwise	3.5 × 1.5 (89 × 38)	31.5 (800)	. . .	1.4 %	3.4 %	2.7 %	3.9 %	6.7 %	9.5 %

[A] The precision indexes are the average values of five specimens tested in eleven laboratories which were found to be in statistical control and in compliance with the standard requirements.

[3] Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR: RR:D07-1005. Contact ASTM Customer Service at service@astm.org.

14. Summary of Test Method

14.1 The specimen is subjected to a force uniformly distributed on the contact surface in a direction generally parallel to the longitudinal axis of the wood fibers, and the force generally is uniformly distributed throughout the specimen during loading to failure without flexure along its length.

15. Significance and Use

15.1 The compressive properties obtained by axial compression will provide information similar to that stipulated for flexural properties in Section 6.

15.2 The compressive properties parallel to grain include modulus of elasticity (E_{axial}), stress at proportional limit, compressive strength, and strain data beyond proportional limit.

16. Apparatus

16.1 *Testing Machine*—Any device having the following is suitable:

16.1.1 *Drive Mechanism*—A drive mechanism for imparting to a movable loading head a uniform, controlled velocity with respect to the stationary base.

16.1.2 *Load Indicator*—A load-indicating mechanism capable of showing the total compressive force on the specimen. This force-measuring system shall be calibrated to ensure accuracy in accordance with Practices E4.

16.2 *Bearing Blocks*—Bearing blocks shall be used to apply the load uniformly over the two contact surfaces and to prevent eccentric loading on the specimen. At least one spherical bearing block shall be used to ensure uniform bearing. Spherical bearing blocks may be used on either or both ends of the specimen, depending on the degree of parallelism of bearing surfaces (Fig. 5). The radius of the sphere shall be as small as practicable, in order to facilitate adjustment of the bearing plate to the specimen, and yet large enough to provide adequate spherical bearing area. This radius is usually one to two times the greatest cross-section dimension. The center of the sphere shall be on the plane of the specimen contact surface. The size of the compression plate shall be larger than the contact surface. It has been found convenient to provide an adjustment for moving the specimen on its bearing plate with respect to the center of spherical rotation to ensure axial loading.

16.3 *Compressometer:*

16.3.1 *Gauge Length*—For modulus of elasticity calculations, a device shall be provided by which the deformation of the specimen is measured with respect to specific paired gauge points defining the gauge length. To obtain test data representative of the test material as a whole, such paired gauge points shall be located symmetrically on the lengthwise surface of the specimen as far apart as feasible, yet at least one times the larger cross-sectional dimension from each of the contact surfaces. At least two pairs of such gauge points on the opposite sides of the specimen shall be used to measure the average deformation.

16.3.2 *Accuracy*—The device shall be able to measure changes in deformation to three significant figures. Since gauge lengths vary over a wide range, the measuring instruments should conform to their appropriate class in accordance with Practice E83.

17. Compression Specimen

17.1 *Material*—The test specimen shall consist of a structural member that is greater than nominal 2 by 2 in. (38 by 38 mm) in cross section (see 3.2.7).

17.2 *Identification*—Material or materials of the specimen shall be as fully described as for flexure specimens in 8.2.

17.3 *Specimen Measurements*—The weight and dimensions (length and cross-section) of the specimen, shall be measured before the test to three significant figures. Sufficient measurements of the cross section shall be made along the length of the specimen to describe shape characteristics and to determine the smallest section. The physical characteristics of the specimen, as described by its density or specific gravity, shall be permitted to be determined in accordance with Test Method D2395.

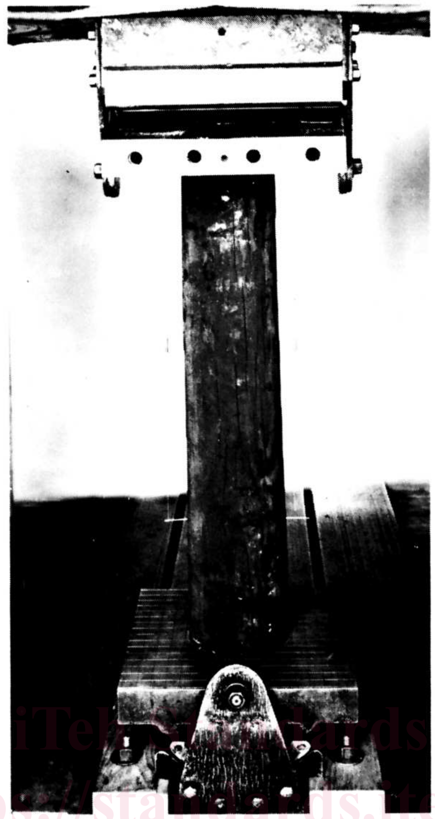

FIG. 5 Example Test Setup for a Short Specimen Compression Parallel to Grain Test (Two Bearing Blocks Illustrated)

17.4 *Specimen Description*—The inherent imperfections and intentional modifications shall be described as for flexure specimens in 8.4.

17.5 *Specimen Length*—The length of the specimen shall be such that the compressive force continues to be uniformly distributed throughout the specimen during loading—hence no flexure occurs. To meet this requirement, the specimen shall be a short specimen having a maximum length, ℓ, less than 17 times the least radius of gyration, r, of the cross section of the specimen (see compressive notations). The minimum length of the specimen for stress and strain measurements shall be greater than three times the larger cross section dimension or about ten times the radius of gyration.

18. Procedure

18.1 *Conditioning*—Unless otherwise indicated in the research program or material specification, condition the specimen to constant weight so it is at moisture equilibrium, under the desired environment. Approximate moisture contents with moisture meters or measure more accurately by weights of samples in accordance with Test Methods D4442.

18.2 *Test Setup:*

18.2.1 *Bearing Surfaces*—After the specimen length has been calculated in accordance with 18.5, cut the specimen to the proper length so that the contact surfaces are plane, parallel to each other, and normal to the long axis of the specimen. Furthermore, the axis of the specimen shall be generally parallel to the fibers of the wood.

NOTE 5—A sharp fine-toothed saw of either the crosscut or "novelty" crosscut type has been used satisfactorily for obtaining the proper end surfaces. Power equipment with accurate table guides is especially recommended for this work.

NOTE 6—It is desirable to have failures occur in the body of the specimen and not adjacent to the contact surface. Therefore, the cross-sectional areas adjacent to the loaded surface may be reinforced.

18.2.2 *Centering*—First geometrically center the specimens on the bearing plates and then adjust the spherical seats so that the specimen is loaded uniformly and axially.

18.3 *Speed of Testing*—The loading shall progress at a constant deformation rate such that the average time to maximum load for the test series shall be at least 4 min. It is permissible to initially test a few random specimens from a series at an alternate rate as the test rate is refined. Otherwise, the selected rate shall be held constant for the test series.

18.4 *Load-Deformation Curves*—If load-deformation data have been obtained with a compressometer described in 16.3, it shall be permitted to remove the apparatus at any point after either the proportional limit or 40 % of the expected average maximum load is achieved. Note the load at first failure, at points of sudden change in specimen behavior, and at maximum load. If the deformation measurement is continued to failure, then it shall also be recorded at the same points.

18.5 *Records*—Record the maximum load, as well as a description and sketch of the failure relating the latter to the location of imperfections in the specimen. Reexamine the section of the specimen containing the failure during analysis of the data.

18.6 *Moisture Content Determination*—Determine the specimen moisture content in accordance with 9.6.

19. Calculation

19.1 Compute physical and mechanical properties in accordance with Terminology E6, and as follows (see compressive notations):

19.1.1 Stress at proportional limit, $\sigma'_c = P'/A$ in psi (MPa).

19.1.2 Compressive strength, $\sigma_c = P_{max}/A$ in psi (MPa).

19.1.3 Modulus of elasticity, $E_{axial} = P'/A\varepsilon$ in psi (MPa).

20. Report

20.1 Report the following information:

20.1.1 Complete identification;

20.1.2 History of seasoning and conditioning;

20.1.3 Load apparatus;

20.1.4 Deflection apparatus;

20.1.5 Length and cross-section dimensions;

20.1.6 Gauge length;

20.1.7 Rate of load application;

20.1.8 Computed physical and mechanical properties, including specific gravity and moisture content, compressive strength, stress at proportional limit, modulus of elasticity, and a statistical measure of variability of these values;

20.1.9 Description of failure; and

20.1.10 Details of any deviations from the prescribed or recommended methods as outlined in the standard.

COMPRESSION PARALLEL TO GRAIN (CRUSHING STRENGTH OF LATERALLY SUPPORTED LONG SPECIMEN, EFFECTIVE $\ell/r \geq 17$)

21. Scope

21.1 This test method covers the determination of the compressive properties of structural members when such a member has a slenderness ratio (length to least radius of gyration) of more than 17, and when such a member is to be evaluated in full size but with lateral supports that are spaced to produce an effective slenderness ratio, ℓ/r, of less than 17. This test method is intended primarily for structural members of rectangular cross section but is also applicable to irregularly shaped studs, braces, chords, round poles and piles, or special sections.

22. Summary of Test Method

22.1 The compression specimen is subjected to a force uniformly distributed on the contact surface in a direction generally parallel to the longitudinal axis of the wood fibers, and the force generally is uniformly distributed throughout the specimen during loading to failure without flexure along its length.

23. Significance and Use

23.1 The compressive properties obtained by axial compression will provide information similar to that stipulated for flexural properties in Section 6.

23.2 The compressive properties parallel to grain include modulus of elasticity (E_{axial}), stress at proportional limit, compressive strength, and strain data beyond proportional limit.

24. Apparatus

24.1 *Testing Machine*—Any device having the following is suitable:

24.1.1 *Drive Mechanism*—A drive mechanism for imparting to a movable loading head a uniform, controlled velocity with respect to the stationary base.

24.1.2 *Load Indicator*—A load-indicating mechanism capable of showing the total compressive force on the specimen. This force-measuring system shall be calibrated to ensure accuracy in accordance with Practices E4.

24.2 *Bearing Blocks*—Bearing blocks shall be used to apply the load uniformly over the two contact surfaces and to prevent eccentric loading on the specimen. One spherical bearing block shall be used to ensure uniform bearing, or a rocker-type bearing block shall be used on each end of the specimen with their axes of rotation at 0° to each other (Fig. 6). The radius of the sphere shall be as small as practicable, in order to facilitate adjustment of the bearing plate to the specimen, and yet large enough to provide adequate spherical bearing area. This radius is usually one to two times the greatest cross-section dimension. The center of the sphere shall be on the plane of the specimen contact surface. The size of the compression plate shall be larger than the contact surface.

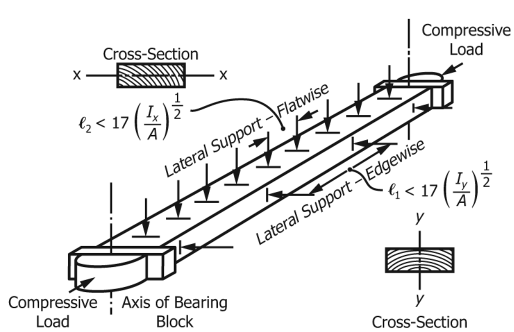

FIG. 6 Minimum Spacing of Lateral Supports of Long Compression Specimens