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: D5764 – 23a

Standard Test Method for Evaluating Dowel-Bearing Strength of Wood and Wood-Based Products[1]

This standard is issued under the fixed designation D5764; 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 provides the basic procedure for evaluating dowel-bearing strength of wood and wood-based products. The bearing test results are used to determine the static load resistance and deformation characteristics of connections in wood and wood-base products resulting from the application of a load transmitted by a fastener inserted into a predrilled hole, or driven without drilling. Methods are given for preparing specimens with predrilled holes larger than the fastener diameter and specimens with holes produced by inserting fasteners in holes smaller than the fastener diameter. The methods apply to fasteners such as dowels, bolts, nails, spikes, drift pins, screws, lag screws, and staples.

1.2 This test method also provides the basis for determining the compression behavior of wood products beneath a laterally loaded fastener where the thickness of the product and the diameter of the fastener are such that minimal bending of the fastener occurs during testing.

1.3 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.

1.4 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.5 *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]

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

D4442 Test Methods for Direct Moisture Content Measurement of Wood and Wood-Based Materials

E4 Practices for Force Calibration and Verification of Testing Machines

E2309 Practices for Verification of Displacement Measuring Systems and Devices Used in Material Testing Machines

3. Terminology

3.1 *Definitions:*

3.1.1 *dowel-bearing behavior, n*—the load-deformation behavior of wood or wood-base products laterally loaded by a fastener where the fastener does not bend during loading.

3.1.2 *dowel-bearing strength, n*—yield load obtained from the load-deformation curve of a dowel-bearing test divided by the dowel diameter and specimen thickness.

4. Summary of Test Method

4.1 Specimens consisting of a single rectangular parallelepiped member with a fastener hole perpendicular to the faces of the member are evaluated for the resistance to embedding the fastener into the fastener hole, so as not to bend the fastener. Tests are conducted on a testing machine at a uniform deformation rate, while loads and deformation are measured at various intervals. Supplementary physical properties of the wood or wood-base member are also determined.

5. Significance and Use

5.1 The localized crushing behavior of wood or wood-base products beneath a fastener where the fastener does not bend provides a material property that is used in theoretical models for connections where crushing or fastener bending, or both,

[1] This test method is under the jurisdiction of ASTM Committee D07 on Wood and is the direct responsibility of Subcommittee D07.05 on Wood Assemblies.

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[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.

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occur. These theoretical models are used to establish design values for wood and wood-base connections. The tests are appropriate when studying the effects of such variables as fastener diameter, fastener hole size, moisture content, specific gravity, and grain direction on the dowel-bearing strength.

6. Apparatus

6.1 *Testing Machine*—Any suitable testing machine capable of operation at a constant rate of motion of its movable head and having an accuracy of ±1 % when calibrated in accordance with Practices E4.

6.2 *Deformation Gage(s)*—Deformation-measuring device(s) shall be used for measuring the embedment of the dowel into the wood or wood-based specimen. These devices shall achieve at least a Class B rating when verified in accordance with Practices E2309.

6.3 *Loading Configuration*—To promote uniform embedment stress along the dowel, the moveable crosshead shall be equipped with a spherical loading block to allow for minor alignment movement prior to loading.

7. Sampling

7.1 Sampling shall provide for selection of representative test specimens which are appropriate to the objectives of the testing program.

7.2 Sample size shall be estimated using procedures in Practice D2915.

NOTE 1—The precision required, the manner of sampling, and the number of tests will depend upon the specific test objectives. General experience indicates that the coefficient of variation from embedment tests ranges from 15 % to 30 %.

8. Specimens

8.1 Wood members shall be selected, and the dowel positioned in such a way that the results are not affected by knots, cross grain, or other natural or manufacturing characteristics, unless the objective of the study is to determine the effect of such variables. Frequently, this will necessitate selecting members which are essentially clear and straight grained. For wood-based products, specimens shall be selected with regard to manufactured characteristics.

8.2 *Specimen Dimensions:*

8.2.1 Specimens shall be prepared in the form of a rectangular prism with either a half-hole (Fig. 1) or full-hole (Fig. 2) provided for the dowel bearing test. The dowel and wood or wood-based specimen grain orientations shall be positioned in the direction required to satisfy the test objectives.

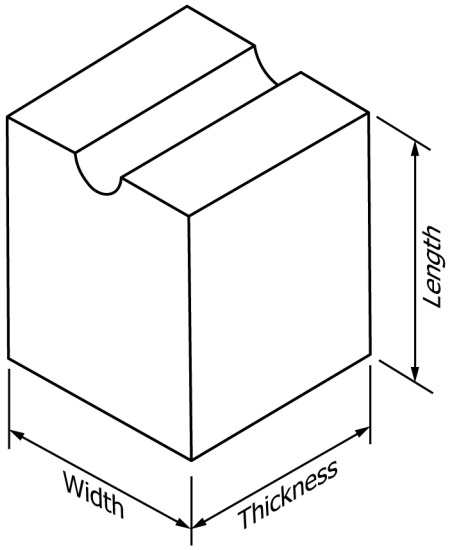
NOTE 2—The thickness, width, and lengths referred to in this standard are used to define the test specimen geometry. Depending upon the fastener and load-to-grain orientation to be evaluated, they will often not correspond with the common terminology for the product being tested.

8.2.2 *Test Configuration Types:*

8.2.2.1 *Half-Hole*—This configuration is used where the test dowel is expected to bend inelastically under load in a full-hole configuration. This method shall also be permitted for larger dowels that do not bend inelastically nor induce splitting with this configuration. Except where addressed by 8.2.3, the minimum dimensions shall be large enough so splitting does not occur during specimen preparation or testing and not less than as follows (see Fig. 1):

Thickness	≥ the smaller of 1½ in. (38 mm), or 2 dowel diameters
Width	≥ the larger of 2 in. (51 mm) or 4 dowel diameters
Length	≥ the larger of 2 in. (51 mm) or 4 dowel diameters

NOTE 3—For materials that tend to split or are unstable under load using the half-hole configuration, larger than minimum dimensions or the full-hole method are recommended.



NOTE 1—Half of the fastener hole is produced by drilling an oversized hole or by the method shown in Fig. 3.

FIG. 1 Specimen Configuration – Half-Hole

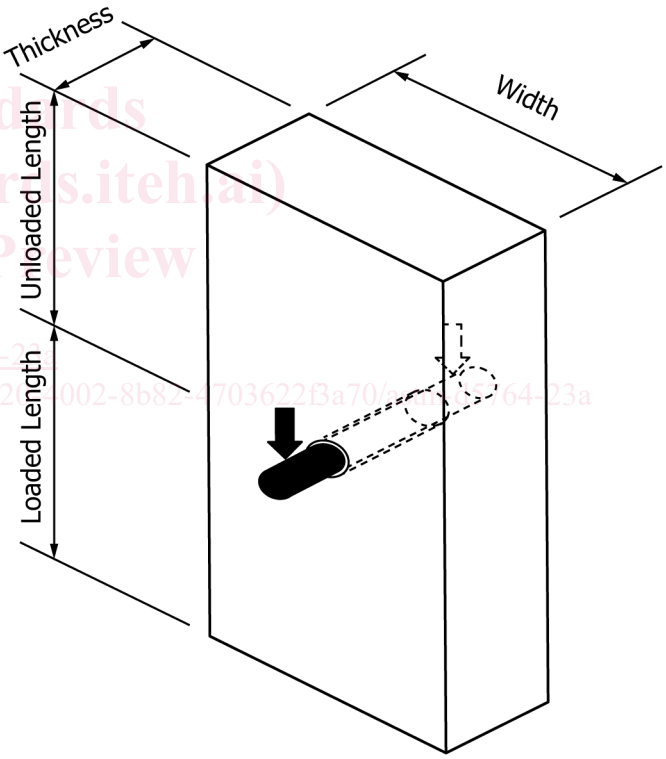


FIG. 2 Specimen Configuration — Full-Hole

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8.2.2.2 *Full-Hole*—This configuration is preferred whenever a specimen length of at least 3 in. (76 mm) can be produced to reduce splitting and increase the specimen stability in the test frame. It shall not be used if the dowel is expected to bend inelastically under load during the test. Except where addressed by 8.2.3, the minimum dimensions shall be made large enough so splitting does not occur during fabrication or testing and not less than as follows (see Fig. 2):

Thickness	≥ the smaller of 1½ in. (38 mm) or 2 dowel diameters
Width	≥ the larger of 2 in. (51 mm) or 4 dowel diameters
Length:	
Loaded End	≥ the larger of 2 in. (51 mm) or 4 dowel diameters
Unloaded End	≥ the larger of 1 in. (25 mm) or 2 dowel diameters

8.2.3 If the product being evaluated is only produced with a size (usually product thickness) less than the minimum required specimen dimension for the orientation being tested, then either the largest available product size shall be used or multiple layers of the same product shall be glue laminated to a thickness that satisfies the minimum dimension requirements. With either preparation method, the test dowel shall be positioned within the product in such a way that it will produce the most conservative test result for the orientation to be evaluated.

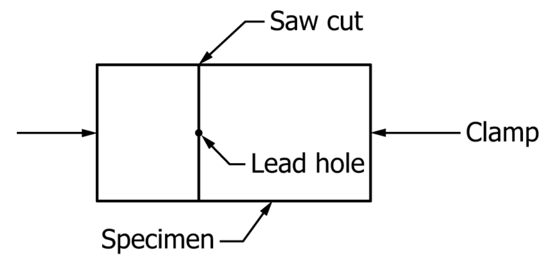
NOTE 4—For example, if a dowel is tested to represent a fastener inserted into the edge of a panel or other composite product with core density that is lower than the face layers, the dowel should be inserted into the low density core of the product and not the high density face.

8.2.4 Fastener holes for fasteners that are installed in drilled holes that are equal to or greater than the fastener diameter shall be typical of those used in service. Drill the hole perpendicular and through the specimen and into an adjacent wood block to minimize splitting of the face where the drill bit exits. Then saw the specimen through the hole to produce a specimen with a half hole. For bolts, the hole shall be 1⁄16 in. (1.6 mm) larger than the bolt diameter. If other hole sizes are specified for the fastener, specimens shall have the specified hole size.

8.2.5 Fastener holes for fasteners that are driven or inserted by other means in holes that are smaller than the fastener diameter shall be typical of those in service. Use a pilot hole of the size specified for service conditions for the fastener. When pilot holes are used with nails, they shall be less than 75 % of the nail diameter (except wood members with specific gravity greater than 0.60 shall have lead holes less than 90 % of the nail diameter). The fastener shall be driven perpendicular to and through the test specimen and into an adjacent wood block to minimize spalling of the face where the fastener exits. If when removed, the fastener does not affect the hole surface, a half hole shall be produced by removing the fastener and sawing through the hole. When removed, if the fastener affects the hole surface, a half hole shall be produced by the procedure outlined in Fig. 3.

9. Conditioning

9.1 The tests shall be made with material conditioned to the appropriate conditions for the objectives of the testing program. Care shall be taken to maintain the desired condition of the material prior to and during testing, unless specified otherwise.



NOTE 1—The procedure is as follows:

(*1*) Cut specimen at point where fastener is to be installed.
(*2*) Clamp the two pieces together with sufficient pressure to maintain contact between adjoining faces during fastening.
(*3*) Drill lead hole in seam of abutting pieces.
(*4*) Drive or insert fastener in lead hole.
(*5*) Remove clamps and smaller piece.
(*6*) The remaining piece is the test specimen with the fastener inserted in the hole.

FIG. 3 Alternative Means of Producing a Half-Hole Specimen for Test Dowels Representative of Dowel-Type Fasteners Typically Driven or Inserted by Other Means

10. Procedure

10.1 *Half-Hole Testing Setup*—Place the dowel in the dowel hole. Place the specimen in the testing machine (see Fig. 4), so that a compressive load can be uniformly applied to the dowel along its length. A steel loading block of sufficient size to prevent bending of the dowel during loading shall be used between the dowel and movable crosshead.

NOTE 5—It may be necessary to provide lateral support to thin specimens loaded in compressions.

10.2 *Full-Hole Testing Setup*—Place the dowel in the dowel hole. Place the specimen in the testing machine so that a compressive load can be applied to the ends of the dowel using an assembly as shown in Fig. 5.

NOTE 6—It may be necessary to provide lateral support to thin specimens loaded in compression.

NOTE 7—If bending of the dowel is observed during loading, consideration of a half-hole test setup is recommended.

NOTE 8—For full-hole bolt embedment specimens, experience has shown that a thickness of 2 to 3 bolt diameters (2 diameters ≤ thickness ≤ 3 diameters) and an end distance equal to or greater than seven bolt diameters will provide embedment displacements at failure greater than the 5 % offset limit.

10.3 *Deformation Measurement*—The embedment of the test dowel shall be directly measured as the movement between the dowel and the stationary surface of the test machine using two deformation gages that are symmetrically positioned at each end of the dowel, aligned with the direction of loading, and placed as close as possible to the specimen surface. The measured deformations shall be averaged to represent the dowel embedment. Alternatively, it shall be permitted to measure this deformation as the movement of the movable crosshead of the testing machine relative to the stationary surface.

NOTE 9—Equipment setup should be checked for tightness to ensure that there is no significant relaxation under load that would be erroneously recorded as dowel embedment. For the best accuracy, direct measurement of the dowel deformation is the recommended practice because it will reduce the amount of extraneous deformation included in the dowel

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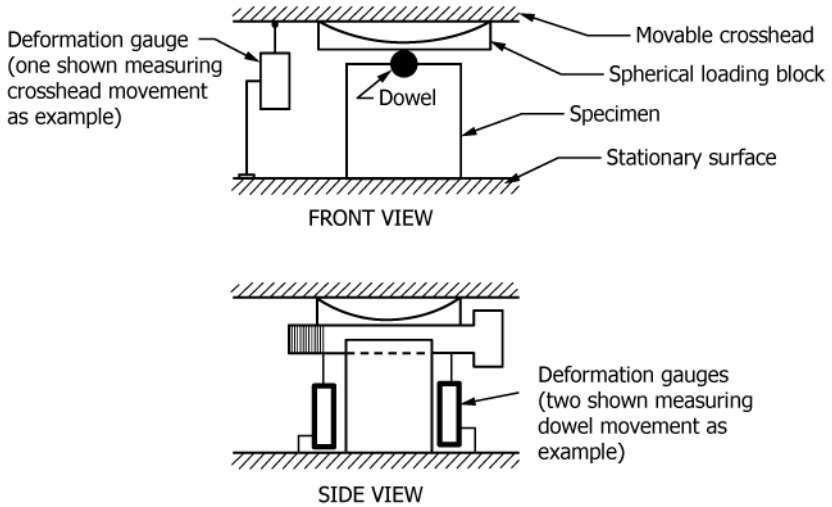

FIG. 4 Schematic of Test Setup — Half-Hole

bearing assessment. The use of a crosshead measurement has been retained because it has historically been permitted by the standard.

10.4 *Rate of Testing*—Conduct the test to reach maximum load in 1 to 10 min. Record the rate of testing used.

NOTE 10—A constant rate of movement of the moveable crosshead of the testing machine of 0.04 in./min (1.0 mm/min) ±50 % usually permits reaching maximum load in the prescribed time.

10.5 *Testing*—Measure the deformation from the beginning of load application, and take readings at sufficiently frequent load intervals to permit establishment of a satisfactory load-deformation curve. Observe the general behavior of the specimen, and record the observations. Record the first relaxation of load indicated on the testing machine load scale, the mode of failure, maximum load, and other significant details. The test shall be terminated at an embedment of one half the fastener diameter or after maximum load has been reached.

10.6 *Minor Tests:*

10.6.1 Determine the oven-dry specific gravity and moisture content of each specimen tested. Procedures for determining these properties are given in Test Methods D2395 and D4442.

11. Interpretation of Results

11.1 *Yield Load*—The bearing yield load (see Fig. 6) is determined by the following procedure:

11.1.1 Fit a straight line to the initial linear portion of the load-deformation curve.

11.1.2 Offset this line by a deformation equal to 5 % of the fastener diameter.

11.1.3 Select the load at which the offset line intersects the load-deformation curve. In those cases where the offset line does not intersect the load-deformation curve, the maximum load shall be used as the yield load.

NOTE 11—Compute the dowel-bearing strength by dividing the yield load by the fastener diameter and the specimen thickness.

11.2 *Proportional Limit Load*—The proportional limit load (see Fig. 6) is the load at which the load-deformation curve deviates from a straight line fitted to the initial portion of the load-deformation curve.

12. Report

12.1 Report the following information:

12.1.1 Data on load deformation relationships, maximum load, and yield load,

12.1.2 Mode of failure,

12.1.3 Description of the wood species or wood-base product being tested,

12.1.4 Member dimensions, including length, width, thickness, and fastener hole diameter or lead hole diameter,

12.1.5 Details of loading procedure and deformation measurement system,

12.1.6 Number of replicate tests,

12.1.7 Oven-dry specific gravity,

12.1.8 Moisture content at time of test of each specimen,

12.1.9 Moisture content at time of fabrication of each specimen if different than moisture content at time of test,

12.1.10 Orientation of the wood grain with respect to the direction of the applied load,

12.1.11 Dimensions and other descriptive information about the fastener, and

12.1.12 Details of any deviation from the prescribed or recommended methods as outlined in this test method.

13. Precision and Bias

13.1 The precision and bias of this test method has not yet been determined.

14. Keywords

14.1 dowel-bearing strength; wood-base

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