



Standard Test Methods for Mechanical Fasteners in Wood¹

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This standard has been approved for use by agencies of the U.S. Department of Defense.

INTRODUCTION

The use of wood and wood-base materials in many structural and other applications often involves the use of mechanical fasteners, such as nails, screws, bolts, lag screws, and connectors. Data on the strength and performance of such fasteners are frequently needed for design and for comparative purposes. Tests of mechanical fasteners (except nail withdrawal) have been generally regarded as special tests and have not been included in the standard methods already established for evaluating the properties of wood. Many such special tests have been extensively used over a considerable period but have not previously been established as standards. Presented herewith are methods of conducting tests for nail, staple, and screw (except machine screws) withdrawal resistance; lateral load transmission by nail, staple, screw, bolt, and timber connector; and load transmission by nail plates. The use of standard methods for these tests is recommended as a means of obtaining comparable data and of eliminating variables in test results because of variations in testing methods.

The tests appear in the following order:

Nail, Staple, or Screw Withdrawal Test	Sections
Lateral Nail, Staple, or Screw Resistance Test	1 to 12
Testing Bolted and Timber Connector Joints	13 to 20
Keywords	21 to 30
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NAIL, STAPLE, OR SCREW WITHDRAWAL TEST

appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

1. Scope

1.1 These test methods provide a basic procedure for evaluating the resistance of wood and wood-base materials to direct withdrawal of nails, staples, and screws. Spikes are included as nails in this standard.

1.2 The tests also provide a basis for determining comparable performance of different types and sizes of nails, staples, and screws in direct withdrawal from wood and wood-base materials.

1.3 *This standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user of this standard to establish appro-*

2. Referenced Documents

2.1 *ASTM Standards:*²

- D143 Test Methods for Small Clear Specimens of Timber
- D2395 Test Methods for Density and Specific Gravity (Relative Density) of Wood and Wood-Based Materials
- D4442 Test Methods for Direct Moisture Content Measurement of Wood and Wood-Based Materials
- E4 Practices for Force Verification of Testing Machines

2.2 *Other Standards:*

- Federal Specification FF-W-92 for Washers, Metal, Flat (Plain)³
- ANSI B18.6.1 American National Standard for Slotted and

¹ These test methods are under the jurisdiction of ASTM Committee D07 on Wood and are 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.

³ Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098.

Recessed Head Wood Screws⁴

3. Summary of Test Method

3.1 Specimens consist of prisms of wood or wood-base products, with nails, staples, or screws driven at right angles to one or more faces. The fasteners are withdrawn at a uniform rate of speed by means of a testing machine, and the maximum load is recorded. Supplementary physical properties of the wood or wood-base product are also determined.

4. Significance and Use

4.1 The resistance of a species of wood or a wood-base product to direct withdrawal of nails, staples, or screws is a measure of its ability to hold or be held to an adjoining object by means of such fasteners. Factors that affect this withdrawal resistance include the physical and mechanical properties of the wood; the size, shape, and surface condition of the fasteners; the speed of withdrawal; physical changes to wood or fasteners between time of driving and time of withdrawal; orientation of fiber axis; and the occurrence and nature of prebored lead holes.

4.2 By using a standard size and type of nail, staple, or screw, withdrawal resistance of a wood species or wood product can be determined, and such values for two or more wood species or wood products can be compared. Throughout the method this is referred to as the basic withdrawal test. Similarly, comparative performances of different sizes or types of nail, staple, or screw can be determined by using a standard procedure with a particular wood or wood product, which eliminates the wood or the wood product as a variable. Since differences in test methods can have considerable influence on results, it is important that a standard procedure be specified and adhered to, if test values are to be related to other test results.

5. Apparatus

5.1 *Testing Machine*—Any suitable testing machine that is capable of operation at a constant rate of motion of the movable head and has an accuracy of $\pm 1\%$ when calibrated in accordance with Practices E4.

5.2 *Grips*—A gripping device shaped to fit the base of the fastener head and of such a design as to allow accurate specimen positioning and true axial loading, is required. A clamping assembly that will hold the specimen to one platen of the machine is also required. A suitable test mechanism for screw withdrawal is illustrated in Fig. 1.

6. Test Materials

6.1 *Nails*:

6.1.1 Nails used for basic withdrawal tests shall be bright plain-shank diamond-point round-wire, low-carbon-steel nails nominally 0.113 in. (2.87 mm) in diameter (Note 1). They shall be cleaned before use to remove any coating or surface film

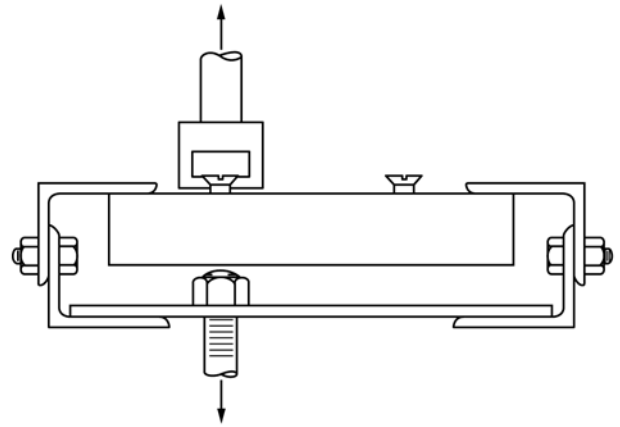


FIG. 1 Diagram of Assembly for Screw Withdrawal Test

that may be present as a result of manufacturing operations and exposure. Each nail shall be used but once.

NOTE 1—A sixpenny common wire nail meets this requirement.

6.1.2 For determining holding ability of different sizes or types of nails in wood or wood products, the respective sizes and types of nail will be as circumstances dictate. These nails shall be representative of the normal manufacturing process, and special cleaning of the shank shall normally not be undertaken.

6.2 *Staples*:

6.2.1 Staples used for basic leg withdrawal resistance shall be standard 2 in. (51 mm) long, $\frac{7}{16}$ in. (11.1 mm) crown, 15 gage (0.072 in.) (1.83 mm) galvanized steel staples. They shall be cleaned before use. Each staple shall be used but once.

6.2.2 For determining holding ability of different types or sizes of staples in wood or wood products, the respective staples shall be representative of the normal manufacturing process, and special cleaning of the legs shall not normally be undertaken.

6.3 *Screws*:

6.3.1 Screws used for basic withdrawal tests shall be standard 1-in. (25 mm) No. 10-gage flathead low-carbon-steel wood screws as described in the American National Standard for Slotted and Recessed Head Wood Screws (ANSI B18.6.1). Each screw shall be used but once.

6.3.2 For determining holding ability of different sizes and types of screws in wood or wood products, the respective size and types of screw will be as circumstances dictate. These screws shall be representative of the normal manufacturing process.

6.4 *Wood and Wood Products*—Prisms shall be cut accurately and square to the required dimensions, and be planned smooth. They shall be of representative density, free of defects and growth irregularities, and of specified moisture content.

7. Sampling

7.1 Sampling should provide for selection of representative test material on an objective and unbiased basis, covering an appropriate range in density and properties as circumstances suggest.

⁴ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036.

7.2 The tests should be sufficiently extensive to provide reliable results. Where analysis by statistical procedures is contemplated, experience and sometimes advance estimates can be used to establish the scope of testing and type of sampling needed to achieve the expected reliability.

NOTE 2—The precision required, and thus the manner of sampling and number of tests, will depend upon specific objectives. No specific criteria therefore can be established. General experience indicates that the coefficient of variation from tests of fasteners ranges from about 15 to 30 %. When such is the case, precision of 5 to 10 %, with 95 % confidence (an often accepted general measure of reliability for testing wood) cannot be achieved without making a rather large number of tests. The present recommendation is to make at least 10 replications for each variable as a minimum requirement.

8. Test Specimen

8.1 Nail and Staple Withdrawal:

8.1.1 For basic withdrawal tests from wood, the wood prism shall be 2 by 2 by 6 in. (51 by 51 by 152 mm). Nails of the type outlined in 6.1.1 and staples of the type outlined in 6.2.1 shall be driven at right angles to the face of the specimen to a total penetration of 1¼ in. (32 mm). Two fasteners shall be driven into a tangential surface, two into a radial surface, and one into each end. End and edge distances shall be sufficient to avoid splitting. In general, edge distances should not be less than ¾ in. (19 mm), end distances not less than 1½ in. (38 mm) and two fasteners shall not be driven in line with each other or less than 2 in. (51 mm) apart on radial or tangential faces. Nails shall be driven manually with a hammer. Staples shall be inserted with an appropriate tool, as nearly as possible perpendicular to the specimen surface, with the staple crown at a 45° (±10°) angle to the grain direction of the prism.

8.1.2 For basic withdrawal tests from wood products, the test prism shall be a single thickness of convenient size not smaller than 3 in. (76 mm) wide and 6 in. (152 mm) long. Nails of the type outlined in 6.1.1 and staples of the type outlined in 6.2.1 shall be driven through the wood product at right angles to the face, permitting at least ½ in. (13 mm) of the shank portion to remain above the surface. Nails shall be driven manually by means of a hammer. Staples shall be inserted with an appropriate tool as in 8.1.1, but if there is no discernible grain direction in the wood product, the staple crown shall be oriented at a 45° (±10°) angle to the length of the prism.

8.1.3 For determining the withdrawal resistance of particular sizes and shapes of nails or staples in wood or wood products, the specimen shall be of convenient size to accommodate the quantity of fasteners to be tested in each specimen, without exceeding the edge and end distances and spacings necessary to avoid splitting. In wood, fasteners should be driven to 70 % of their length; in thin panel wood products they should be driven completely through the thickness with at least ½ in. (13 mm) of the shank portion remaining above the surface. The fasteners shall be driven by the method intended to be used in practice, that is, either manually with a hammer, or with an applicator or appropriate tool if this is the normal method.

8.1.3.1 If the withdrawal resistance may be influenced by the material through which the fastener is to be driven, the fastener shall be driven through the fastened member (cleat) into the fastening member.

8.2 Screw Withdrawal:

8.2.1 For basic withdrawal tests from wood, the specimen shall be 2 in. (51 mm) wide, 6 in. (152 mm) long, with depth at least equal to the length of the screw. Two screws of the type outlined in 6.2.1 shall be threaded into lead holes at right angles to the tangential face, to a total penetration equal to the length of the threaded portion. End and edge distance shall be sufficient to avoid splitting, which in general will be at least ¾ in. (19 mm) from the edge and 1½ in. (38 mm) from the end, and spacing will be at least 2½ in. (63 mm). The size of the lead hole shall be 70 % of the root diameter of the screw for softwoods and hardwoods and shall extend ½ in. (13 mm) into the face of the specimen. The screws may be coated with paraffin wax or other similar lubricant when necessary to facilitate driving.

8.2.2 For basic withdrawal tests from wood products, the specimen shall be 3 in. (76 mm) in width, and 6 in. (152 mm) in length. The depth of the specimen shall be at least equal to the length of the screw, and it may be necessary to glue together two or more thicknesses of material to provide the required depth. Screws of the type outlined in 6.2.1 shall be threaded into the specimen a distance of ⅔ in. (17 mm) at midwidth, at least 2 in. (51 mm) from the end of the specimen. The size of lead hole shall be 70 % of the root diameter of the screw and it shall extend ½ in. (13 mm) into the face of the specimen. The screws may be coated with paraffin wax or other similar lubricant when necessary to facilitate driving.

8.2.3 For determining the withdrawal resistance of particular sizes and types of screws in wood or wood products, the specimen shall be of convenient size to accommodate the quantity of screws to be tested in each specimen, without exceeding the edge and end distances and spacings necessary to avoid splitting. Screws shall be threaded into the specimen for the length of the threaded portion of the shank or two thirds of the shank length if it is threaded throughout. The size of lead hole, if one is to be drilled, shall be 70 % of the root diameter of the screw for a distance of one half of the screw length.

8.2.3.1 If the withdrawal resistance may be influenced by the material through which the screw is to be threaded the screw shall be threaded through a held member into the holding member.

9. Conditioning

9.1 Nail, staple, and screw withdrawal tests are normally made on seasoned material. The wood or wood product, whether kiln dried or air-dried, shall be stored in a room having a controlled temperature of 20 ± 3°C (68 ± 6°F) and a controlled relative humidity of 65 ± 3 % for a period sufficiently long to bring it to approximate equilibrium. The fasteners shall not be driven until equilibrium is attained in the wood component.

9.2 Where required, withdrawal tests may be made on drier, partially seasoned or unseasoned material. It may sometimes be desired to apply the fasteners to unseasoned material and allow the completed specimen to season prior to withdrawal. As in 9.1 these specimens should attain the desired moisture equilibrium in a controlled atmosphere to ensure uniform moisture content at the time of test. Soaking in water will