



Designation: **F1575/F1575M – 21** **F1575/F1575M – 24**

Standard Test Method for Determining Bending Yield Moment of Nails, Spikes, and Dowel-type Threaded Fasteners¹

This standard is issued under the fixed designation F1575/F1575M; 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 reappraisal. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reappraisal.

1. Scope*Scope

1.1 This test method covers procedures for determining the bending yield moment of ~~nails and~~ calculation of bending yield strength (F_{yb}) of nails, spikes, and dowel-type threaded fasteners (referred to collectively as fasteners) when subjected to static loading. ~~It is intended only for nails.~~ Bending yield strength is used in engineered connection applications, in which a required connection capacity is specified by the designer.

1.2 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system are not necessarily exact equivalents; therefore, to ensure conformance with the standard, each system shall be used independently of the other, and values from the two systems shall not be combined.

NOTE 1—This test method is applicable in either inch-pounds F1575 or SI Units [F1575M]. Values stated in SI are a mathematical conversion of two significant digits and are shown in brackets [].

1.3 *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.*

1.4 *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 ²⁴ by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 ASTM Standards:²

[E4 Practices for Force Calibration and Verification of Testing Machines](#)

[E2309/E2309M Practices for Verification of Displacement Measuring Systems and Devices Used in Material Testing Machines](#)

[F680 Test Methods for Nails](#)

[F1667/F1667M Specification for Driven Fasteners: Nails, Spikes, and Staples](#)

2.2 ASME Standards:³

[B18.2.1 Square, Hex, Heavy Hex, and Askew Head Bolts, and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws \(inch Series\). 2012. The American Society of Mechanical Engineers, Three Park Avenue, New York, NY.](#)

[B18.6.1 Wood Screws. 1981 \(R2008\). The American Society of Mechanical Engineers, Three Park Avenue, New York, NY.](#)

¹ This test method is under the jurisdiction of ASTM Committee F16 on Fasteners and is the direct responsibility of Subcommittee F16.05 on Driven and Other Fasteners. Current edition approved Dec. 1, 2021/Jan. 1, 2024. Published January 2022/March 2024. Originally approved in 1995. Last previous edition approved in 2017/2021 as F1575 – 17/F1575 – 21. DOI: 10.1520/F1575_F1575M-21-10.1520/F1575_F1575M-24.

² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

³ Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Two Park Ave., New York, NY 10016-5990, <http://www.asme.org>.

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

3. Terminology

3.1 Definitions of Terms Specific to This Standard: Related to All Fasteners of this Standard:

3.1.1 *bending yield moment*—the moment determined from the yield load point on the load-deformation curve that is intermediate between the proportional limit load and maximum load for the nail. It is calculated by the intersection of the load-deformation curve with a line represented by the initial tangent modulus offset 5 % of the fastener diameter. fastener.

3.1.2 *bending yield strength*—the fastener strength characteristic used in yield limit equations to determine lateral capacity of connection; determined from the bending yield moment and dimensions of the fastener.

3.1.3 *deformed shank—certifying body*—a nail shank that has been mechanically deformed with annular rings, barbs, helical flutes, etc. an organization that is recognized through compliance with national standards for the purpose of improved withdrawal capacity; product evaluation.

3.1.2.1 *fully deformed shank*—a nail shank that has deformation along the entire length:

3.1.2.2 *partially deformed shank*—a nail shank that that has both smooth and deformed sections along the length:

3.1.4 *proportional limit load—limit*—is the load at which the load-deformation curve deviates from a straight line fitted to the initial portion of the load-deformation curve. (See curve (Fig. Fig. 1)1).

3.1.5 *shank*—a portion of the fastener below the head, excluding the tip, which is embedded in the connected materials and the portion of the fastener engaged in a nut or similar anchorage device, if applicable.

3.1.6 *transition zone—point*—the location of the transition from smooth shank to deformed shank on a partially deformed-shank nail; nail or spike; the location of the transition from smooth shank to threaded shank or from a reamer knurl to threaded shank for a partially-threaded dowel-type fastener.

3.1.7 *yield load*—load at the intersection of the load-deformation curve and the 5 % offset line, or the maximum load if the load-deformation curve and 5 % offset-line do not intersect.

3.1.8 *yield theory*—the model for determining lateral load design values for dowel-type fasteners that specifically accounts for the different ways these connections behave under load. The capacity of the connection under each yield mode is determined by the bearing strength of the material under the fastener and the bending strength of the fastener, with the lowest capacity calculated for the various yield modes being taken as the design load for the connection.

3.2 Definitions of Terms Related to Nails and Spikes of this Standard:

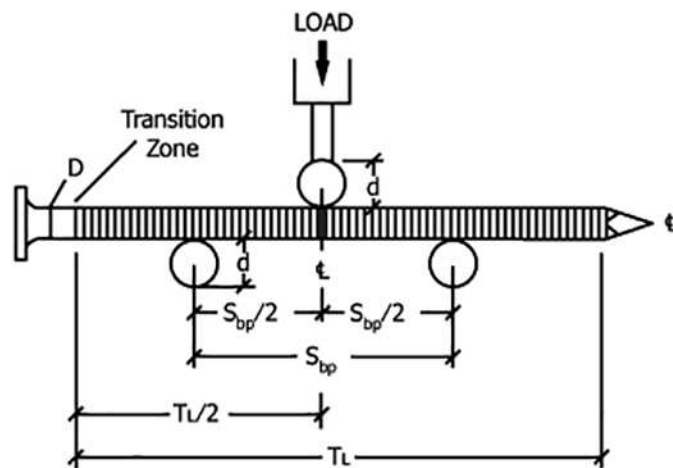


FIG. 4 Load and Bearing Point Location for Partially Deformed Shank Nails with Insufficient Smooth Shank Length reaction bearing point positions for deformed-shank nails and spikes with smooth-shank length that is too short to position the load bearing point at the transition point.

3.2.1 *deformed shank*—a nail or spike shank that has been mechanically deformed with annular rings, barbs, helical flutes, etc. for the purpose of improved withdrawal capacity.

3.2.2 *fully deformed shank*—a nail or spike shank that has deformation along the entire length.

3.2.3 *partially deformed shank*—a nail or spike shank that has been mechanically deformed over a portion of the shank length.

3.3 *Definitions of Terms Related to Dowel-type Threaded Fasteners of this Standard:*

3.3.1 *critical diameter*—the minor diameter in the threaded portion of the fastener.

3.3.2 *dowel-type threaded fastener*—a nominally cylindrical fastener with threads, inserted into materials for the purpose of connecting pieces together. The dowel-type threaded fasteners addressed in this standard include standardized and proprietary screws, standard and self-drilling bolts, and similar fasteners.

3.3.3 *equivalent critical diameter*—a calculated dimension for a shank with non-circular minor diameter cross section that has the same plastic section modulus as a shank with a circular minor diameter.

3.3.4 *fully-threaded shank*—the shank of a dowel-type threaded fastener with a thread along the entire length of the shank.

3.3.5 *minimally-threaded shank*—the shank of a partially-threaded dowel-type fastener that is generally smooth and has a short threaded portion, typically less than three diameters in length, where the lateral load is resisted by the smooth shank.

3.3.6 *minor diameter*—the smallest diameter in the threaded portion of the body (D_{minor}).

3.3.7 *partially-threaded shank*—the shank of a dowel-type threaded fastener having one or more sections of shank that is (are) threaded and one or more sections of shank that is (are) unthreaded.

3.3.8 *reamer knurl*—a screw feature that is a shank deformation located between the smooth portion of the shank and the threaded portion of the shank that facilitates installation in some materials.

3.3.9 *thread*—a type of dowel deformation intended to be keyed into the receiving member, nut, or similar anchorage device by rotation of the fastener.

4. Summary of Test Method

4.1 Test specimens are evaluated to determine capacity to resist lateral bending loads. The test procedure utilizes a three-point

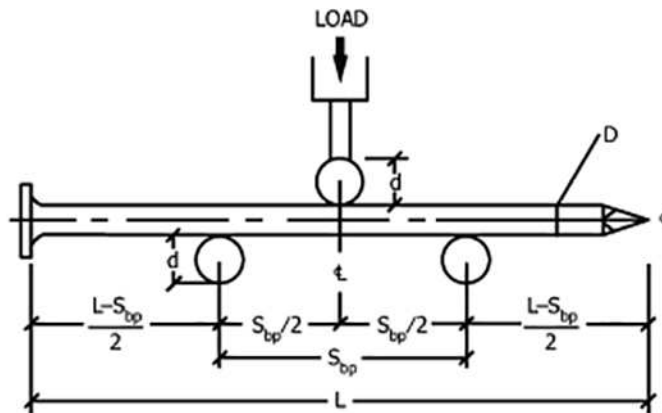


FIG. 32 Load and Bearing Point Locations for Partially Deformed Shank Nailsreaction bearing point positions for smooth-shank and fully deformed-shank nails and spikes.

bending test where the span dimension is based on the nominal diameter of a nail or the critical diameter of a dowel-type threaded

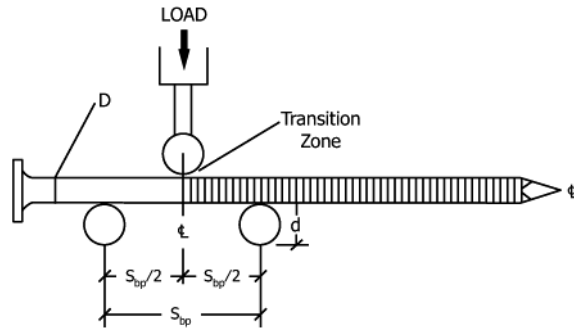


FIG. 23 Load and Bearing Point Locations for Smooth Shank and Fully Deformed Shank Nails

fastener. The load is applied at a constant rate of deformation with a suitable testing machine, and produces a continuous load-deformation response diagram (Fig. 1). The load on the test specimen at various intervals of deformation is measured. Supplementary physical properties of the test specimen are also determined. The precision of the test and resulting calculated properties depend on the measurement of the applicable diameter and the positioning of the fastener on the test span supports.

5. Significance and Use

5.1 Nails are a common mechanical fastener. Nails, spikes, and dowel-type threaded fasteners are common mechanical fasteners in wood structures. Engineering design procedures used to determine the capacities of laterally-loaded nailed connections currently use connections with these types of fasteners rely on a yield theory to establish the nominal resistance for laterally-loaded nailed connections that are engineered. In order to develop the nominal resistance for laterally-loaded nailed connections, the fastener bending yield moment, strength, length, and diameter must be known.

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 Gauge—Deformation measuring device shall be used for measuring the deflection of the fastener during the bending test. The device shall achieve at least a Class B rating when verified in accordance with Practices E2309/E2309M.

6.3 Cylindrical Reaction Bearing Points—Any cylindrical metal member capable of supporting the test specimen during loading without the metal bearing member deforming, as shown in Fig. 3, the figures, and having diameter (d) = 0.375 in. [9.53 mm].

6.3.1 Cylindrical reaction bearing points shall be free to rotate or permit free rotation of the fastener as the test specimen deforms.

6.4 Cylindrical Load Point—Any cylindrical metal member capable of loading the test specimen without the metal loading member deforming, as shown in Figs. 2-4, the figures, and having diameter (d) = 0.375 in. [9.53 mm].

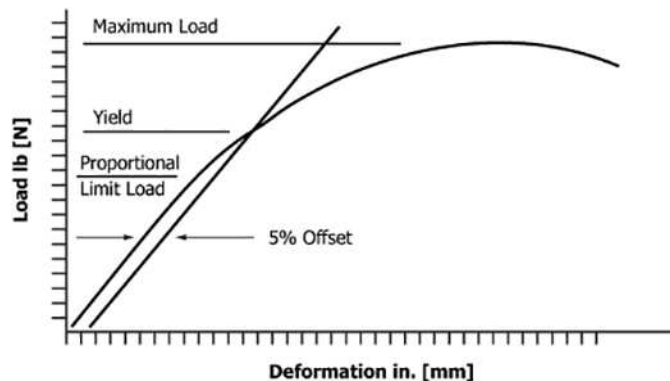


FIG. 1 Example of Typical Load-Deformation Diagram from Nail Bending Test

6.5 *Recording Device*—Any device with at least a reading of 0.001 in. [0.01 mm] or 0.001 in. [0.02 mm] and any suitable device for measuring the load on the test specimen during deformation.

7. Sampling

7.1 Test specimens shall be randomly selected to represent and representative of the parent population of nails fasteners or wire from the manufacturing process, process, as applicable. A minimum of 15 replicate specimens shall be tested for each size or nail type test sample.

7.2 Tests for smooth-shank nails, bolts, and similar fasteners that are not hardened shall be performed on either the finished fastener or a specimen of drawn wire stock from which the fastener would be manufactured.

7.3 Tests for hardened smooth-shank fasteners, deformed-shank nails, and dowel-type threaded fasteners shall be performed on the finished fastener.

8. Specimens and Tests

8.1 Tests for smooth shank nails shall be performed on either the finished nail or a specimen of drawn wire stock from which the nail would be manufactured. Tests for deformed-shank nails shall be performed on the finished nail.

8.2 *Diameter Measurement*—Diameter measurement procedures are addressed in Test Methods F680. Measurement of each test specimen shall take place as follows:

8.2.1 *Smooth Shank Nails*—At the midpoint of the shank length.

8.2.2 *Partially Deformed Shank Nails*—On the smooth portion of the shank at the midpoint between nail head and transition zone. Exception: When gripper marks are present on the smooth portion of the shank and the length of the smooth portion is insufficient for proper measurement, the nail shall be measured in accordance with 8.2.3.

8.2.3 *Fully Deformed Shank Nail*—The diameter of a fully deformed shank nail cannot be accurately measured. Any measurement

ASTM F1575/F1575M-24

<https://standards.iteh.ai/catalog/standards/astm/299cc12e-9ba8-4d48-83cd-1f8421d7e6a7/astm-f1575-f1575m-24>

TABLE 1 Length Between Nail Bearing Points Test Spans

Nails and Spikes	
Nail Nominal Diameter in. or [mm]; tolerance per Specification F1667/F1667M	Length Between Bearing Points, in. or [mm] S _{bp}
Nominal Diameter per F1667/F1667M in. [mm]	Test Span ¹ , S _{bp} in. [mm]
0.099 [2.51]	1.1 [28]
0.113 [2.87]	1.3 [33]
0.120 [3.05]	1.4 [36]
0.131 [3.33]	1.5 [38]
0.148 [3.76]	1.7 [43]
0.162 [4.11]	1.9 [48]
0.190 [4.83]	2.2 [56]
0.190 [4.83]	2.2 [56]
Larger than 0.190 [4.83]	11.5 times the nail diameter, rounded to the nearest tenth of an inch or mm
Larger than 0.190 [4.83]	11.5 times the normal diameter, rounded to the nearest 0.1 in. [2 mm]

Dowel-type Threaded Fasteners

Test span shall be 11.5 times the critical diameter or equivalent critical diameter rounded to the nearest 0.1 in. [2 mm].

Length between bearing points for nails with diameters other than shown in Table 1 are the lengths for the next smaller listed diameter.

1. Test spans for nails and spikes with diameters other than shown are the test spans for the next smaller listed nominal diameter.

across the deformed area of the shank will result in a diameter that differs from the wire stock used to manufacture the nail. When this occurs the manufacturer shall provide representative wire samples from which the nails are manufactured for measurement. This shall be noted in the test report.

8.2.4 All diameter dimensions shall be taken prior to the application of or after the removal of any coatings or finish and shall not be measured across any gripper marks.

8.2.5 Diameters shall be measured to within the nearest 0.001 in. [0.01 mm].

8.3 *Length Measurement*—The nail shall be long enough to prevent the nail head or point from bearing on the cylindrical nail supports during application of load to the nail through the time when maximum load is reached.

8. Procedure

8.1 *Diameter Measurement:*

8.1.1 Diameter measurement procedures are addressed in Test Methods [F680](#). Measurement of each test specimen shall take place as follows:

8.1.1.1 *Smooth Shank Nails and Spikes*—At the midpoint of the shank length.

8.1.1.2 *Partially Deformed Shank Nails and Spikes*—On the smooth portion of the shank at the midpoint between head and transition point. Exception: When gripper marks are present on the smooth portion of the shank and the length of the smooth portion is insufficient for proper measurement, the nail or spike shall be measured in accordance with [8.1.1.3](#).

8.1.1.3 *Fully Deformed Shank Nails and Spikes*—The diameter of fully deformed shank nails and spikes cannot be accurately measured. Any measurement across the deformed area of the shank will result in a diameter that differs from the wire stock used to manufacture the fastener. When this occurs, the manufacturer shall provide representative wire samples from which the nails or spikes are manufactured for measurement. This shall be noted in the test report.

8.1.2 *Dowel-type Threaded Fasteners — Measurement of Test Specimens Shall Take Place as Follows:*

8.1.2.1 *Partially-Threaded and Fully-threaded Shanks with Circular Cross Sections*—The minor diameter is the critical diameter and shall be measured at approximately the load point location.

8.1.2.2 *Minimally-Threaded Shanks with Circular Cross Sections*—The critical diameter is the smooth shank. The smooth-shank diameter shall be measured at approximately the mid length of the smooth-shank portion of the fastener.

8.1.2.3 *Threaded Shanks with Non-circular Cross Sections*—The equivalent critical diameter in the threaded portion of a shank that is not circular in cross section shall be calculated as the product of the diameter of a circle that circumscribes the perimeter of the minor diameter cross section (Fig. 7) and an adjustment factor. The minor diameter dimensions that are the basis of the equivalent diameter calculation shall be determined at the location on the shank where the bending load is to be applied. Section X1.6 describes the method to calculate the adjustment factor that is used to establish the equivalent critical diameter.

NOTE 2—Some examples of shanks with non-circular minor diameter cross sections are trilobular and twisted-square cross sections, which have equivalent critical diameters of 0.66 and 0.81 times the diameters of the circumscribed circles, respectively.

8.1.3 *Coatings*—For nails, spikes and other fasteners with minor diameter < 0.250 in. [6 mm], diameter dimensions shall be taken prior to the application of or after the removal of any coatings or finish and shall not be measured across any gripper marks.

8.1.4 Diameters shall be measured to the nearest 0.001 in. [0.02 mm].

8.2 *Length Measurement:*

8.2.1 *Nails and Spikes*—Length of nails and spikes shall be measured as described in Test Methods [F1667/F1667M](#).

8.2.2 *Dowel-type Threaded Fasteners:*