INTERNATIONAL

Designation: F1575/F1575M – 24

Standard Test Method for Determining Bending Yield Moment of Nails, Spikes, and Dowel-type Threaded Fasteners[1]

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 reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method covers procedures for determining the bending yield moment 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. 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 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.

3. Terminology

3.1 *Definitions of Terms 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 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 *certifying body*—an organization that is recognized through compliance with national standards for the purpose of product evaluation.

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

[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 Feb. 1, 2024. Published March 2024. Originally approved in 1995. Last previous edition approved in 2021 as F1575 – 21. DOI: 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.

3.1.6 *transition point*—the location of the transition from smooth shank to deformed shank on a partially deformed-shank 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:*

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 The test procedure utilizes a three-point bending test where the span dimension is based on the nominal diameter of a nail or the critical diameter of a dowel-type threaded fastener. The load is applied at a constant rate and produces a continuous load-deformation response diagram (Fig. 1). 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, spikes, and dowel-type threaded fasteners are common mechanical fasteners in wood structures. Engineering design procedures used to determine the capacities of laterally-loaded connections with these types of fasteners rely on a yield theory to establish the nominal resistance. In order to develop the nominal resistance for laterally-loaded connections, the fastener bending yield 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

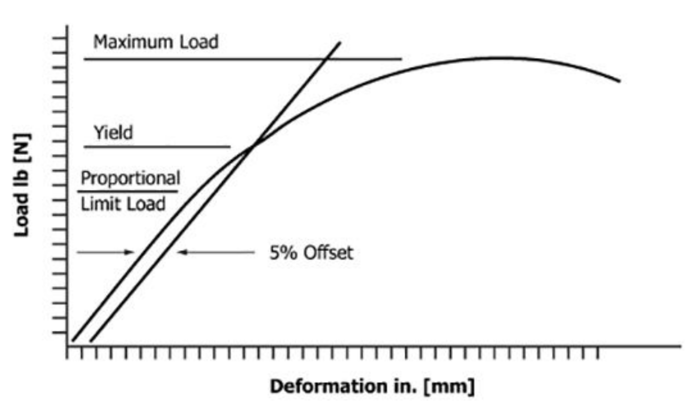

FIG. 1 Example of typical load-deformation diagram from a fastener bending test illustrating the recorded load-deformation curve and 5 % offset line.

loading without the metal bearing member deforming, as shown in 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 the figures, and having diameter (*d*) = 0.375 in. [9.53 mm].

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

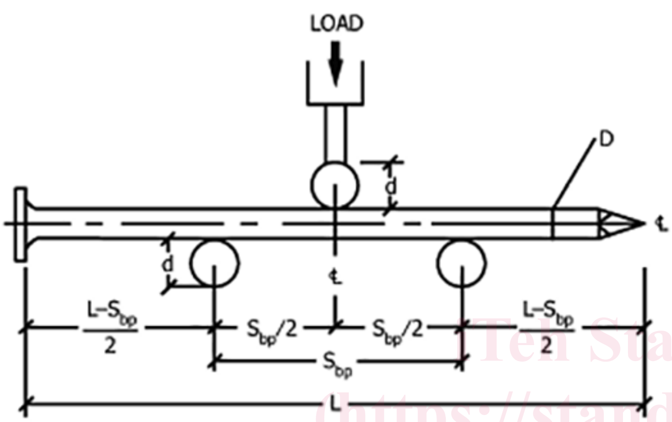

FIG. 2 Load and reaction bearing point positions for smooth-shank and fully deformed-shank nails and spikes.

7. Sampling

7.1 Test specimens shall be randomly selected and representative of the parent population of fasteners or wire from the manufacturing process, as applicable. A minimum of 15 replicate specimens shall be tested for each 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. 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.

TABLE 1 Test Spans

Nominal Diameter per F1667/F1667M in. [mm]	Test Span[1], s_{bp} in. [mm]
Nails and Spikes	
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]
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].	

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

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:*

8.2.2.1 *Screws*—Measurement shall be as described in ASME B18.6.1.

8.2.2.2 *Bolts and Lag Screws*—Measurement shall be as described in ASME B18.2.1.

8.3 *Test Setup:*

8.3.1 *Reaction Bearing Point Spacing (Test Span):*

8.3.1.1 Test span, s_{bp}, shall be as indicated in Table 1 using the appropriate diameter as defined in 8.1.

8.3.1.2 The fastener shall be long enough that the head does not contact the reaction bearing supports during application of load to the fastener from initial loading through the time when maximum load is reached.

8.3.1.3 If the fasteners are too short to meet this requirement and the fasteners receive no processing after forming that can affect fastener bending yield moment, such as heat treating or shank deformation, the test shall be performed on wire from which the fastener is made.

8.3.1.4 If fasteners are too short to meet this requirement and receive processing after forming that can affect fastener bending yield moment, such as heat treating or shank deformation, the fasteners shall be tested with the largest possible span and the span and circumstances shall be cited in the report.

NOTE 3—Experience indicates that test results are sensitive to large changes in test span, s_{bp}.

8.3.2 *Load Position – Nails and Spikes:*

8.3.2.1 For smooth shank and fully deformed shank nails and spikes, the load shall be applied at the midpoint of the nail or spike that is positioned at the center of the test span ($s_{bp}/2$) as shown in Fig. 2.

8.3.2.2 For partially deformed shank nails and spikes, the load shall be applied at the transition point between the smooth portion of the shank and the deformed portion of the shank and at the center of the test span ($s_{bp}/2$) as shown in Fig. 3.

8.3.2.3 When the length of the smooth shank portion is insufficient for specimen placement in accordance with 8.3.2.2 or when a reaction bearing point will come in contact with the nail or spike head, then both bearing points shall be located in the deformed section of the shank with the center of the load being placed at the midpoint of the deformed length (T_L) and at the center of the span as shown in Fig. 4. This shall be noted in the test report.

8.3.3 *Load Position—Dowel-type Threaded Fasteners:*

8.3.3.1 The load point shall not bear on the top of a thread. If necessary to avoid deformation of the threads during the test, it shall be permitted to reduce the interfering thread(s) by grinding at the load point location sufficiently to prevent thread deformation and not further than the minor diameter. It shall be permitted to similarly treat the fastener threads at the reaction bearing points to prevent thread deformation if necessary.

NOTE 4—Experience has shown that minimal thread removal to facilitate localized bearing at the load point and reactions does not have a material effect on mean bending moment, although variation may be increased. Thread removal beyond the interfering threads may result in reduced bending moment. Minimal thread removal can be accomplished using a hand-held grinding tool.

8.3.3.2 Bolts shall be positioned in accordance with 8.3.2.

8.3.3.3 Fully-threaded dowel-type fasteners shall be positioned such that the load point is centered in the test span and at the nominal center of threaded length (T_L) as shown in Fig. 5.

8.3.3.4 Partially-threaded dowel-type fasteners shall be positioned such that the load point is centered in the test span and applied at the second thread pitch of the threaded section as shown in Fig. 6, or as close as possible in the threaded section depending on the thread length geometry. For fasteners with multiple threaded lengths, the load point shall be in the second thread pitch of the threaded-shank portion that is closest to the tip.

8.3.3.5 Minimally-threaded fasteners shall be positioned such that the load is applied at the mid point of the smooth portion of the shank and at the center of the test span ($s_{bp}/2$).

8.4 *Loading:*

8.4.1 The maximum constant rate of loading, r_L, shall be:

$$r_L = 0.25 \text{ in./min} \quad [6.35 \text{ mm/min}]$$

8.4.2 The load shall be applied continuously from initiation until the load decreases.

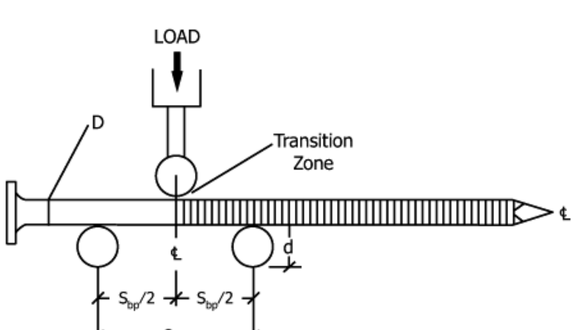

FIG. 3 Load and reaction bearing point positions for partially deformed-shank nails and spikes.

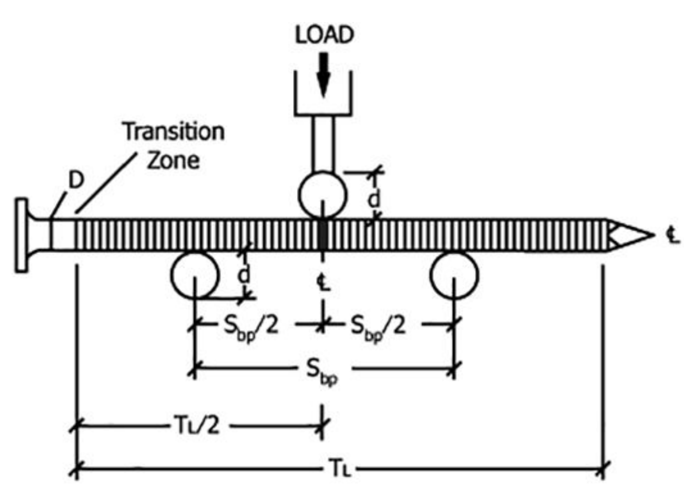

FIG. 4 Load and reaction bearing point positions for deformed-shank nails and spikes with smooth-shank length that is too short to position the load bearing point at the transition point.