Designation: F1575 – 17

Standard Test Method for Determining Bending Yield Moment of Nails[1]

This standard is issued under the fixed designation F1575; 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 of nails when subjected to static loading. It is intended only for nails used in engineered connection applications, in which a required connection capacity is specified by the designer.

1.2 The values stated in inch-pound units are to be regarded as standard. No other units of measurement are included in this standard.

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 and health 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 Verification of Testing Machines

F1667 Specification for Driven Fasteners: Nails, Spikes, and Staples

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *bending yield moment*—the moment determined from 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.

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

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.

3.1.3 *proportional limit load*—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 Fig. 1)

3.1.4 *transition zone*—the location of the transition from smooth shank to deformed shank on a partially deformed-shank nail.

3.1.5 *yield theory*—the model for 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.

4. Summary of Test Method

4.1 Test specimens are evaluated to determine capacity to resist lateral bending loads applied at a constant rate of deformation with a suitable testing machine. The load on the test specimen at various intervals of deformation is measured. Supplementary physical properties of the test specimen are also determined.

5. Significance and Use

5.1 Nails are a common mechanical fastener in wood structures. Engineering design procedures used to determine the capacities of laterally-loaded nailed connections currently use 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 bending yield moment must be known.

[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.

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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.

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

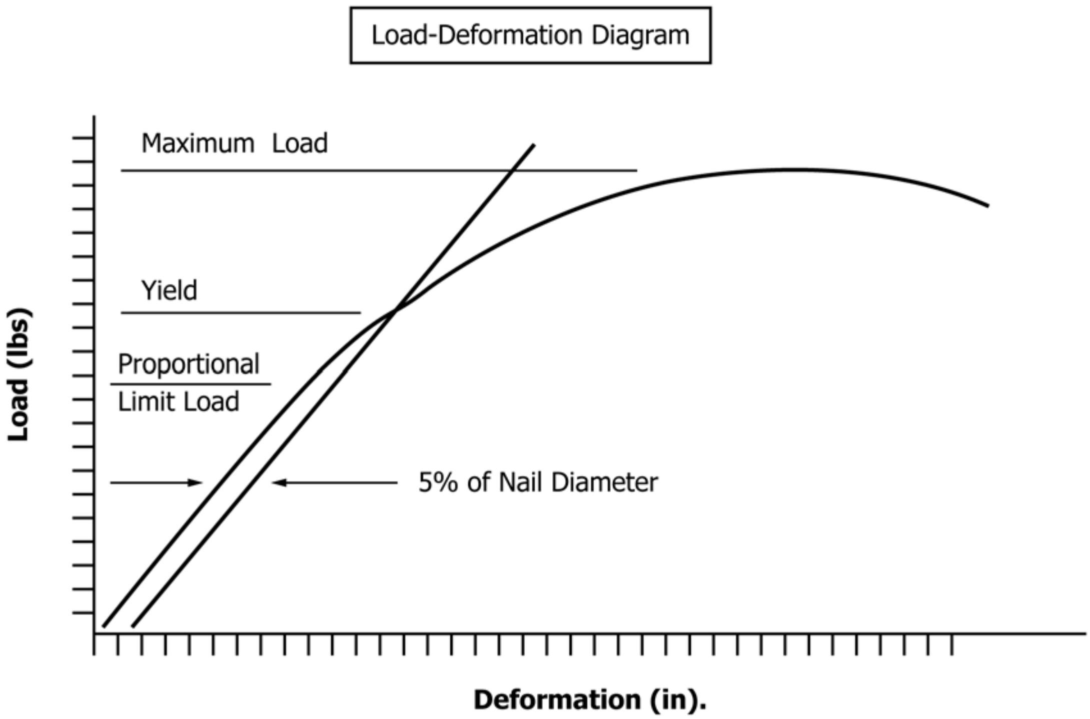

FIG. 1 Example of Typical Load-Deformation Diagram from Nail Bending Test

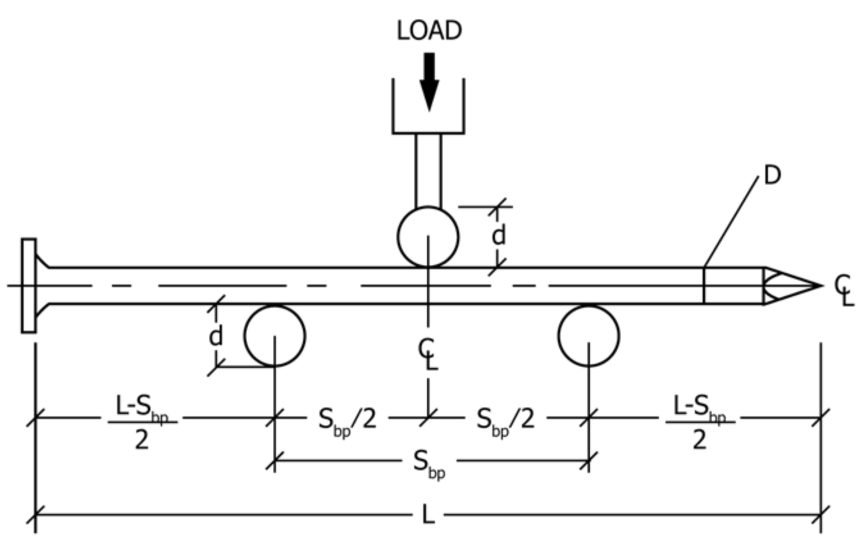

FIG. 2 Load and Bearing Point Locations for Smooth Shank and Fully Deformed Shank Nails

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 *Cylindrical Bearing Points*—Any cylindrical metal member capable of supporting the test specimen during loading without deforming, as shown in Fig. 3, and having diameter (d) = 0.375 in.

6.2.1 Cylindrical bearing points shall be free to rotate as the test specimen deforms.

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

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

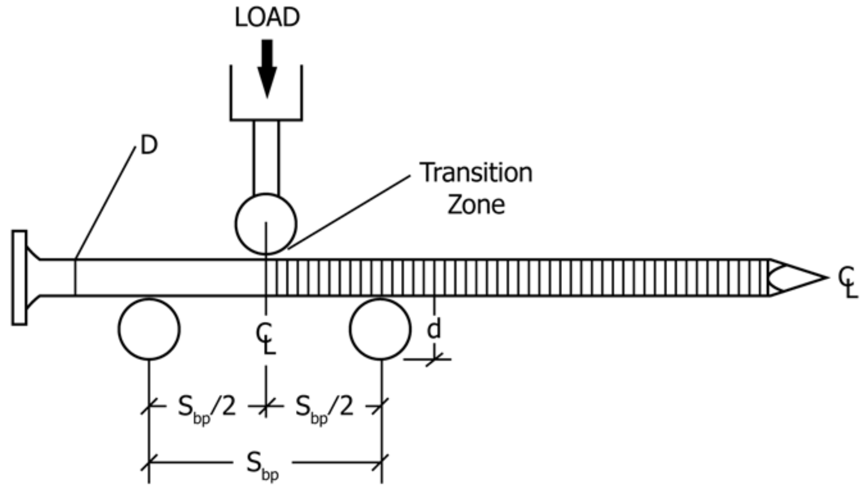

FIG. 3 Load and Bearing Point Locations for Partially Deformed Shank Nails

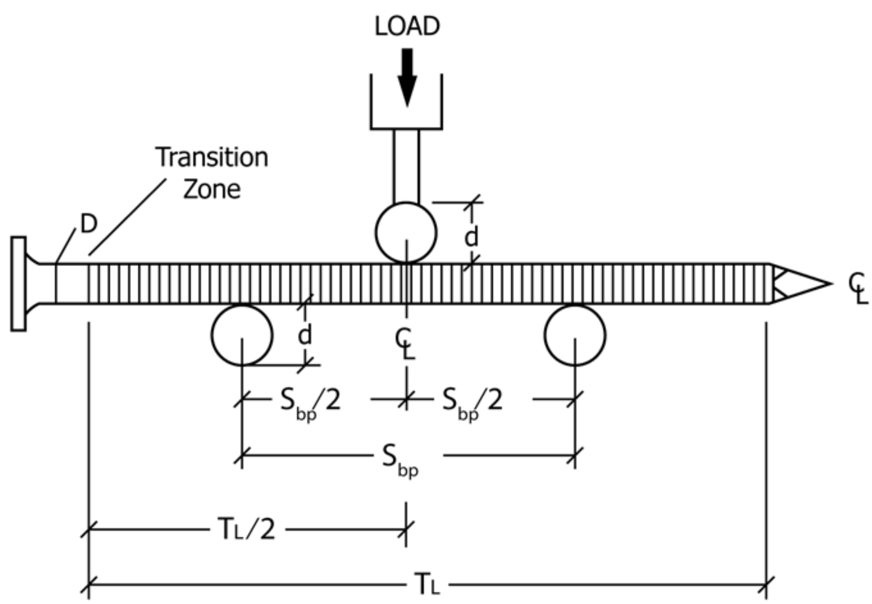

FIG. 4 Load and Bearing Point Location for Partially Deformed Shank Nails with Insufficient Smooth Shank Length

7. Sampling

7.1 Test specimens shall be randomly selected to represent the parent population of nails or wire from the manufacturing process. A minimum of 15 specimens shall be tested for each size or nail type.

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 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.

8.2.3 *Fully Deformed Shank Nail*—The diameter of a fully deformed shank nail 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 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.

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.

TABLE 1 Length Between Nail Bearing Points

Nail Nominal Diameter (in.), tolerance per Specification F1667	Length Between Bearing Points (in.) s_{bp}
0.099	1.1
0.113	1.3
0.120	1.4
0.131	1.5
0.148	1.7
0.162	1.9
0.190	2.2
Larger than 0.190	11.5 times the nail diameter, rounded to the nearest tenth of an inch

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

9. Procedure

9.1 *Test Setup:*

9.1.1 Cylindrical bearing point spacing, s_{bp}, shall be as indicated in Table 1.

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

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

NOTE 1—Experience indicates that test results are sensitive to large changes in bearing point spacing, s_{bp}.

9.1.2 The load for smooth shank and fully deformed shank nails shall be applied to the test specimen so that the center of the cylindrical load point is equidistant from the center of each cylindrical bearing point ($s_{bp}/2$) as shown in Fig. 2.

9.1.3 Partially deformed-shank nails shall be placed on the cylindrical bearing points for testing so that the transition zone between shank and thread is as close to the midpoint between the bearing points as possible as shown in Fig. 3.

9.1.3.1 *Exception*: Only when the length of the smooth shank portion is insufficient for proper distance placement (s_{bp}) of a cylindrical bearing points or when a cylindrical bearing point will come in contact with the nail head, then both bearing points shall be located in the deformed section of the shank with the center of the load being placed midpoint of the thread length T_L as shown in Fig. 4. This shall be noted in the test report.

9.2 *Loading:*

9.2.1 The maximum constant rate of loading, r_L, shall be as follows:

$$r_L = 0.25 \text{ in./min}$$

9.2.2 The procedures described herein are for static loading. Procedures to evaluate nails for impact or cyclic loads are not a part of this test method.

9.3 *Load and Deformation Measurement*—Measure the applied load on and deformation of the test specimen from the initiation of load application and take readings of each at sufficiently frequent intervals to permit establishment of a satisfactory load-deformation curve except as permitted in 9.3.1. Continue the loading until the maximum load is reached and the load capacity begins to decrease.

9.3.1 As an alternative to establishment of a load-deformation curve, initial tests shall be performed to establish a relationship between maximum load and the 5 % offset value in accordance with 10.1. The maximum load only shall then be recorded for subsequent tests.

10. Interpretation of Results

10.1 The bending yield moment is determined by fitting a straight line to the initial linear portion of the load-deformation curve, offsetting this line by a deformation equal to 5 % of the nail diameter, and selecting the load at which the offset line intersects the load-deformation curve (see Fig. 1). In those cases where the offset line does not intersect the load-deformation curve, the maximum load shall be used as the yield load. The bending yield moment shall be the average of the specimens tested.

11. Report

11.1 The following shall be included in the report:

11.1.1 Tabulated and plotted data on load-deformation diagrams (see Fig. 1) or maximum load and the maximum/5 % offset load relationship in accordance with 9.3.1,

11.1.2 Physical description of the test specimen including diameter and deformation characteristics for deformed-shank nails,

11.1.3 Location of transition zone for partially deformed-shank nails between bearing points,

11.1.4 Rate of loading, and

11.1.5 Number of replicate tests.

11.1.6 Individual and average of test data points and calculations (dimensions, F_{yb}, M_y, etc.)

12. Precision and Bias

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

13. Keywords

13.1 bending yield moment; fastener; nail; yield; yield theory

ANNEX

(Mandatory Information)

A1. DERIVATION OF BENDING YIELD STRENGTH DESIGN VALUES, F_{yb}

A1.1 The nominal bending yield strength shall be determined by the following:

$$F_{yb} = \frac{M_y}{S}$$

where

F_{yb} = nominal fastener yield strength, psi,
S = effective plastic section modulus (in.^{3}) for full plastic hinge (for circular, prismatic nails, $S = D^3/6$, where D = nail diameter), and
M_y = calculated moment based on test load, in.-lb

$$M_y = P\, s_{bp}/4$$

where

P = test load as determined from load-deformation curve, as shown in Fig. 2 or as specified in 9.3.1, lb, and
s_{bp} = cylindrical bearing point spacing as shown in 9.1.1, in.

APPENDIX

(Nonmandatory Information)

X1. COMMENTARY

X1.1 This is a test method to evaluate bending yield moment of nails for design and is not intended to be a nail manufacturing test procedure for quality control. This test method provides a means for determining bending yield strength, $F_{yb}D$, so that the supplier/manufacturer is aware of the full requirements for the product being provided.

X1.2 In accordance with 6.2 and 6.3, preliminary studies indicate that loading head and support diameters do not show a significant radius effect on material properties. The diameter shown in this test method is based on one of the larger nails produced, with a ⅜-in. diameter.

X1.3 Centers of the cylindrical bearing points shall remain in the specified position (spacing) during testing. This can be accomplished by using a jig described in *The Testing of Improved Nails*[3]

X1.4 In accordance with 9.2.1, the 0.25-in./min load rate shown in this test method is roughly based on one nail diameter per minute. Several European studies indicate that small changes in rate of loading do not show a significant effect on material properties.

X1.5 In accordance with 9.3.1, the option for establishing a relationship between ultimate load and the 5 % offset value allows simplification of testing. Once the relationship is established with preliminary tests, ultimate load alone can be measured and recorded for each test. Periodic verification by the manufacturer will ensure accurate establishment of 5 % offset design values.

[3] Stern, G (1966). The Testing of Improved Nails. *Materials Research and Standards*, 6(12), 602-607

SUMMARY OF CHANGES

Committee F16 has identified the location of selected changes to this standard since the last issue (F1575 – 03(2013)) that may impact the use of this standard.

(1) Addition of Section:
1.4.
(2) Referenced Documents: Removed E1470.
(3) Changes to Sections:
a. 3.1.1
b. 3.1.3 – 3.1.5
c. 6.1
d. 6.2 – 6.4
e. 7.1
f. 8.2 – 8.3
g. 9.1.1.1 – 9.1.1.2
h. 9.1.2 – 9.1.3
i. 9.3
j. 9.3.1
k. 11.1
l. 11.1.1 – 11.1.3
m. 11.1.6
(4) Replaced Fig. 1.
(5) New Figures Fig. 3 and Fig. 4.
(6) Replaced and Renumbered Fig. 2.
(7) Added Sections:
a. 3.1.2.1
b. 3.1.2.2
c. 8.2.1
d. 8.2.2
e. 8.2.3
f. 8.2.4
g. 8.2.5
h. 9.1.3.1
(8) Clarification of equations in Annex A1.
(9) Removed commentary X1.3 and renumbered subsequent sections.
(10) Updated reference in X1.3.