



Standard Test Method for Determining Bending Yield Moment of Nails¹

This standard is issued under the fixed designation F 1575; 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 *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.*

2. Referenced Documents

2.1 ASTM Standards:

E 4 Practices for Force Verification of Testing Machines²

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

3.1.3 *true center line*—the line passing through, and parallel to, the center of the shank.

3.1.4 *yield theory*—the model for lateral load design values for dowel-type fasteners which 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 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.

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 Practice E 4.

6.2 *Cylindrical Bearing Points*—Any cylindrical metal member capable of supporting the test specimen during loading without deforming, as shown in Fig. 1, 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 Fig. 1, and having diameter (D) = 0.375 in.

6.4 *Recording Device*—Any device with at least a reading of 0.001 in. (0.025 mm) and any suitable device for measuring the load on the test specimen during deformation.

7. Sampling

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

8. Specimens and Tests

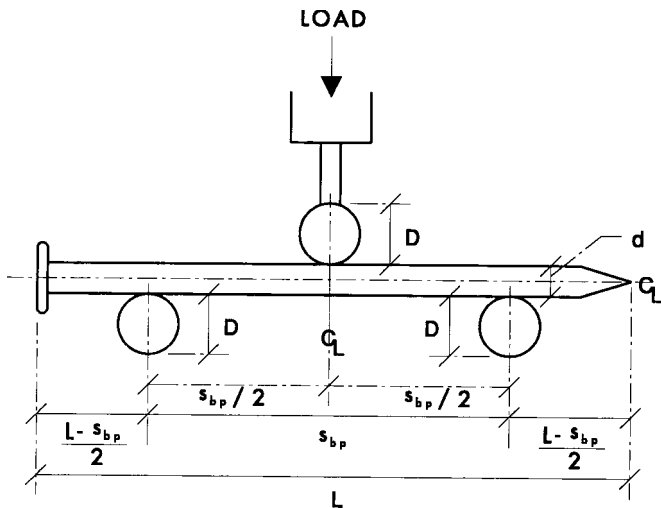
8.1 Tests for smooth shank nails shall be performed on either the finished nail or a specimen of drawn wire stock from which the nail would be manufactured. Tests for deformed-shank nails shall be performed on the finished nail.

8.2 *Diameter Measurement*—Measure the actual diameter of each test specimen at the midpoint of its length to the nearest 0.001 in. (0.025 mm). The nail diameter shall be defined as the diameter of the unthreaded shank for partially deformed-shank

¹ This test method is under the jurisdiction of ASTM Committee F-16 on Fasteners and is the direct responsibility of Subcommittee F16.05 on Driven and Other Fasteners.

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² *Annual Book of ASTM Standards*, Vol 03.01.



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

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 ultimate 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 ultimate load and the 5 % offset value in accordance with 10.1. The ultimate 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. 2). 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 Report the following information:

11.1.1 Tabulated and plotted data on load-deformation relationships or ultimate load and the ultimate/5 % offset load relationship in accordance with 9.3.1,

11.1.2 Physical description of the test specimen including diameter, carbon content of the steel, and thread characteristics for deformed-shank nails,

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

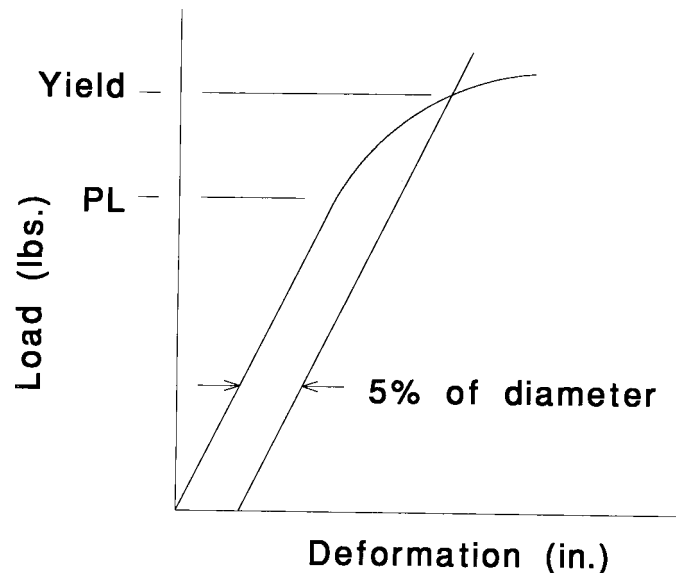


FIG. 2 Typical Load-deformation Diagram from Nail Bending Test

nails and shall be measured at the midpoint of the length of nail shank between nail head and transition zone.

8.3 *Length Measurement*—The minimum length for test specimens shall be 1.5 in.

9. Procedure

9.1 *Test Setup:*

9.1.1 Cylindrical bearing point spacing, s_{bp} , shall be as follows:

$$s_{bp} = 1.5 \text{ in. when test specimen diameter } (d) \leq 0.15 \text{ in.}$$

$$s_{bp} = 2.5 \text{ in. when } 0.15 \text{ in.} < d \leq 0.25 \text{ in.}$$

$$s_{bp} = 3.75 \text{ in. when } d > 0.25 \text{ in.}$$

9.1.1.1 Test specimens shall be placed on the cylindrical bearing points for testing so that each end is equidistant from the cylindrical bearing points $(L - s_{bp})/2$ as shown in Fig. 1, except that deformed-shank nails shall be placed to satisfy the requirements of 9.1.3.

9.1.2 The load 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. 1.

9.1.3 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.

9.2 *Loading:*

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

- 11.1.4 Rate of loading, and
- 11.1.5 Number of replicate tests.

13. Keywords

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

12. Precision and Bias

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

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.-lbs.

$$P s_{bp}/4$$

where

- P = test load as determined from load-deformation curve, as shown in Fig. 2 or as specified in 9.3.1, lbs, 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 3/8-in. diameter.

X1.3 In accordance with 7.1, the number of samples to test to provide for a representative selection should be agreed upon by the nail manufacturer and customer. An ASTM standard is being developed entitled "Standard Guide in Fastener Sampling for Specified Mechanical Properties and Performance Inspection" that will provide guidance in this area.

X1.4 In accordance with 9.1.1, preliminary studies indicate that small changes in test spans do not show a significant effect on material properties. The test span ranges shown in this test

method are roughly based on 10 nail diameters. 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*, ASTM Materials Research and Standards.³

X1.5 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.

X1.6 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 Available from University Microfilms, Inc., 300 N. Zeeb Road, Ann Arbor, MI 48106, Vol 6, No. 12, pp. 602-607, December 1966.

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