ICC EVALUATION SERVICE

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July 14, 2010

TO: **PARTIES INTERESTED IN EVALUATION REPORTS ON ALTERNATE DOWEL-TYPE THREADED FASTENERS**

SUBJECT: Revisions to the Acceptance Criteria for Alternate Dowel-type Threaded Fasteners, Subject AC233-0610-R1 (JS/DM)

Dear Madam or Sir:

Enclosed is a copy of the subject revised acceptance criteria approved by the ICC-ES Evaluation Committee on June 17, 2010, effective July 1, 2010. The revisions may be summarized as follows:

1. Section 2.4 has been corrected to reference Section 3.1 of AC85 (rather than Section 3.2). Section 3.1 is the appropriate section of AC85, regarding test specimen sampling for products subject to third-party quality control inspections.

2. In Sections 4.3, 4.5.2, and 4.6, an alternative has been added to allow a reduced minimum sample size of 10 (rather than 15), for cases where a 5 percent precision of estimate at 95 percent (rather than 75 percent) confidence is achieved. This alternative is identical to the original provisions of AC233 (prior to October 2009), and it eliminates the need for retesting of alternate dowel-type threaded fasteners currently recognized in an ICC-ES evaluation report.

3. Changes have been made to Section 4.6 and Table 5 to require fastener pull-through capacities to be expressed in units of pounds, rather than pounds per inch of side member thickness. The fastener pull-through values given within the evaluation report will be applicable to installations with side member thicknesses that are greater than or equal to that of the tested configuration. These revisions have been made to address concerns regarding the appropriateness of permitting linear extrapolation of fastener pull-through capacity values for an unlimited range of side member thicknesses, based solely on the test data for one particular side member thickness.

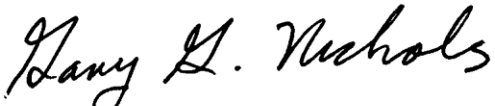
4. Section 6.3.2 has been revised to clarify that the structural members at a connection must also be checked for load-carrying capacity in accordance with NDS Section 10.1.2.

5. Various editorial revisions have also been made.

Evaluation reports issued on or after the effective date noted above, and falling within the scope of this criteria, will be required to comply with the enclosed edition of the criteria. Evaluation reports issued prior to the effective date may be in compliance either with the enclosed acceptance criteria or with the previous edition. Evaluation reports based on a superseded version of an acceptance criteria must be brought into compliance with the most recent edition at the time the reports are reissued. Therefore, applicants should submit data verifying compliance at the time they apply for re-examination.

If you have any questions, please contact Jason Smart, Senior Evaluation Specialist, at (800) 423-6587, extension 5692. You may also reach us by e-mail at es@icc-es.org.

Yours very truly,



Gary G. Nichols, P.E., SECB
Vice President

GGN/raf

Enclosure

cc: Evaluation Committee

ICC EVALUATION SERVICE

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ACCEPTANCE CRITERIA FOR ALTERNATE DOWEL-TYPE THREADED FASTENERS

AC233

Approved June 2010

Effective July 1, 2010

Previously approved October 2009, February 2007, October 2006, February 2006, October 2005, June 2005, June 2004

PREFACE

Evaluation reports issued by ICC Evaluation Service, Inc. (ICC-ES), are based upon performance features of the International family of codes and other widely adopted code families, including the Uniform Codes, the BOCA National Codes, and the SBCCI Standard Codes. Section 104.11 of the *International Building Code*® reads as follows:

> The provisions of this code are not intended to prevent the installation of any materials or to prohibit any design or method of construction not specifically prescribed by this code, provided that any such alternative has been approved. An alternative material, design or method of construction shall be approved where the building official finds that the proposed design is satisfactory and complies with the intent of the provisions of this code, and that the material, method or work offered is, for the purpose intended, at least the equivalent of that prescribed in this code in quality, strength, effectiveness, fire resistance, durability and safety.

Similar provisions are contained in the Uniform Codes, the National Codes, and the Standard Codes.

This acceptance criteria has been issued to provide all interested parties with guidelines for demonstrating compliance with performance features of the applicable code(s) referenced in the acceptance criteria. The criteria was developed and adopted following public hearings conducted by the ICC-ES Evaluation Committee, and is effective on the date shown above. All reports issued or reissued on or after the effective date must comply with this criteria, while reports issued prior to this date may be in compliance with this criteria or with the previous edition. If the criteria is an updated version from the previous edition, a solid vertical line (|) in the margin within the criteria indicates a technical change, addition, or deletion from the previous edition. A deletion indicator (→) is provided in the margin where a paragraph has been deleted if the deletion involved a technical change. This criteria may be further revised as the need dictates.

ICC-ES may consider alternate criteria, provided the report applicant submits valid data demonstrating that the alternate criteria are at least equivalent to the criteria set forth in this document, and otherwise demonstrate compliance with the performance features of the codes. Notwithstanding that a product, material, or type or method of construction meets the requirements of the criteria set forth in this document, or that it can be demonstrated that valid alternate criteria are equivalent to the criteria in this document and otherwise demonstrate compliance with the performance features of the codes, ICC-ES retains the right to refuse to issue or renew an evaluation report, if the product, material, or type or method of construction is such that either unusual care with its installation or use must be exercised for satisfactory performance, or if malfunctioning is apt to cause unreasonable property damage or personal injury or sickness relative to the benefits to be achieved by the use of the product, material, or type or method of construction.

Acceptance criteria are developed for use solely by ICC-ES for purposes of issuing ICC-ES evaluation reports.

ACCEPTANCE CRITERIA FOR ALTERNATE DOWEL-TYPE THREADED FASTENERS (AC233)

1.0 INTRODUCTION

1.1 Purpose: The purpose of this acceptance criteria is to establish requirements for alternate dowel-type threaded fasteners to be recognized in an ICC Evaluation Service, Inc. (ICC-ES), evaluation report under the 2006 and 2009 *International Building Code*® (IBC), the 2006 and 2009 *International Residential Code*® (IRC), and the 1997 *Uniform Building Code*™ (UBC). Bases of recognition are IBC Section 104.11 and IRC Section R104.11. The reason for development of this criteria is to provide guidelines for the evaluation of alternate fasteners, held in place by threaded anchorage in the main member, to those addressed by the code or the code reference, the NDS.

1.2 Scope: This criteria is applicable to alternate dowel-type threaded fasteners used for wood-to-wood or steel-to-wood connections. A fastener is considered an alternate when it has different dimensions than those specified in ANSI B18.2.1 or ANSI B18.6.1, or when it is self-drilling (installed without a lead hole).

1.3 Codes and Referenced Standards: Where standards are referenced in this criteria, the standards shall be applied consistently with the code (IBC or IRC) upon which compliance of the fastener is based.

1.3.1 2009 *International Building Code*® (2009 IBC), International Code Council.

1.3.2 2009 *International Residential Code*® (2009 IRC), International Code Council.

1.3.3 2006 *International Building Code*® (2006 IBC), International Code Council.

1.3.4 2006 *International Residential Code*® (2006 IRC), International Code Council.

1.3.5 1997 *Uniform Building Code*™ (UBC).

1.3.6 AISI S100-07, North American Specification for the Design of Cold-Formed Steel Structural Members, American Iron and Steel Institute.

1.3.7 AISI (2008) Cold-formed Steel Design Manual, Part VI—Test Standards for Use with the 2007 Edition of the North American Specification for the Design of Cold-Formed Steel Structural Members, American Iron and Steel Institute.

1.3.8 ANSI/AF&PA National Design Specification for Wood Construction (NDS), 2005 edition, American Forest & Paper Association.

1.3.9 ANSI/AF&PA Technical Report 12, General Dowel Equations for Calculating Lateral Connection Values, 1999, American Forest & Paper Association.

1.3.10 ANSI/ASME Standard B18.2.1-1996, Square and Hex Bolts and Screws (Inch Series), American Society of Mechanical Engineers.

1.3.11 ANSI/ASME Standard B18.6.1-1981 (reaffirmed 1997), Wood Screws (Inch Series), American Society of Mechanical Engineers.

1.3.12 ASTM D 1037-06a, Standard Test Methods for Evaluating Properties of Wood-Base Fiber and Particle Panel Materials, ASTM International.

1.3.13 ASTM D 1761-88 (2000)e01, Test Methods for Mechanical Fasteners in Wood, ASTM International; (2006 IBC referenced standard).

1.3.14 ASTM D 1761-06, Test Method for Mechanical Fasteners in Wood, ASTM International (2009 IBC referenced standard).

1.3.15 ASTM D 2395-07a, Standard Test Method for Specific Gravity of Wood and Wood-Based Materials, ASTM International.

1.3.16 ASTM D 2915-03, Standard Practice for Evaluating Allowable Properties for Grades of Structural Lumber, ASTM International.

1.3.17 ASTM D 4442-07, Standard Test Methods for Direct Moisture Content Measurement of Wood and Wood-Base Materials, ASTM International.

1.3.18 ASTM D 4444-08, Standard Test Methods for Use and Calibration of Hand-Held Moisture Meters, ASTM International.

1.3.19 ASTM D 5764-97a (2007), Standard Test Method for Evaluating Dowel-Bearing Strength of Wood and Wood-Based Products, ASTM International.

1.3.20 ASTM E 8-08, Standard Test Methods for Tension Testing of Metallic Materials, ASTM International.

1.3.21 ASTM F 1575-03, Standard Test Method for Determining Bending Yield Moment of Nails, ASTM International.

1.3.22 NASM1312-20 (1997), National Aerospace Standard Practice for Fastener Test Methods, Method 20, Single Shear; Aerospace Industries Association of America, Inc.

2.0 BASIC INFORMATION

2.1 General: The following information shall be submitted:

2.1.1 Product Description: Complete information concerning material specifications, diameters (shank, outside thread and minor), thread type (cut or rolled), size, and the manufacturing process.

2.1.2 Installation Instructions: Installation details and limitations.

2.1.3 Packaging and Identification: A description of the method of packaging and field identification of the screws. Where practical with respect to available space on the fastener head, each fastener shall be identified by the manufacturer's identifying mark or logo and the length designation. Each container of fasteners shall have a label noting the evaluation report holder's name and address, the evaluation report number, and the fastener size.

2.2 Testing Laboratories: Testing laboratories shall comply with Section 2.0 of the ICC-ES Acceptance Criteria for Test Reports (AC85) and Section 4.2 of the ICC-ES Rules of Procedure for Evaluation Reports.

2.3 Test Reports: Test reports shall comply with AC85.

2.4 Product Sampling: Sampling of the fastener(s) for tests under this criteria shall comply with Section 3.1 of AC85.

3.0 TEST AND PERFORMANCE REQUIREMENTS

3.1 General: Alternate dowel-type threaded fasteners shall be evaluated as described in this section. Fastener and steel part material specifications shall conform to a national industry standard. Tests shall be performed for each variation of fastener length, thread length, side and main member thickness, steel strength, specific gravity, side and main member orientation, and fastener diameter, unless a pattern of performance and failure mode can be established. Alternatively, reference design values may be interpolated from a regression line fitted to tests of connections when all of the following conditions are met: (1) only specific gravity is allowed to vary in the test series; (2) a sufficient number of tests is conducted to result in a coefficient of determination greater than or equal to 0.90, and a percentage standard error of estimate of less than 10 percent; and (3), in lateral load testing, a regression line shall pertain to tests exhibiting a common yield mode.

3.1.1 Reference design values for connections with wood members may be derived for species identified in NDS Table 11.3.2A. Members of target species used in test connections shall have a specific gravity determined on an oven-dry weight and volume basis equal to or lower than the NDS table values, and shall be equilibrated to a target moisture content. Testing of specific gravity and moisture content shall be in accordance with Section 4.1.

3.1.2 Reference design values derived from connection tests may be assigned to like connections with wood species having a higher specific gravity than tested. However, reference design values for connections with wood species exceeding a specific gravity of 0.50 shall be evaluated if predrilled holes meeting the requirements of NDS Section 11.1.4 are not used.

3.1.3 When testing described in Section 4.0 of this criteria requires a 5 percent precision, a 75 percent confidence interval, a minimum of 15 specimens, and a maximum of 40 specimens, there is an implied limit on the COV of 27 percent. If 40 specimens are tested with a COV above 27 percent, the product has failed the test.

3.2 Design of Metal Fasteners and Side Plates: Design of metal fasteners and steel side plates shall comply with Section 10.2.3 of the NDS.

3.2.1 Tensile and shear tests shall be performed on the fastener in accordance with Section 4.2 of this criteria.

3.2.2 Standard tensile test specimens of the sheet steel or plate from which the side member is produced shall be made in accordance with ASTM E 8.

3.2.3 The allowable tensile or shear design load of a fastener shall be taken as the average maximum load from the tests divided by a safety factor of 3.0.

3.2.4 When the capacity of a connection is controlled by fastener or steel side plate metal strength, rather than wood strength, the metal strength shall not be permitted to be multiplied by the adjustment factors specified in the NDS.

3.3 Reference Withdrawal Design Values: Fastener withdrawal strength shall be tested in accordance with Section 4.3. The tested reference withdrawal capacity shall be the average maximum test value divided by a factor of 5 and divided by the length of the embedded thread. The calculated reference withdrawal capacity shall be the tabulated design value, *W*, computed using the equations in NDS Section 11.2, where *G* is taken as the average tested specific gravity and *D* is taken as the outside thread diameter. When using equation 11.2-1, both the calculated and tested reference withdrawal capacities shall be determined without including the fastener tip. When using equation 11.2-2, both the calculated and tested capacities shall include the fastener tip. The lesser of the tested or calculated reference withdrawal capacities shall be used. If the thread geometry of the tested fastener does not conform to NDS Appendix L, ANSI Standard B18.2.1, or ANSI Standard B18.6.1, the tested reference withdrawal capacity may be used regardless of the calculated capacity. Adjustment factors are permitted to be applied to the reference design value per NDS Table 10.3.1.

3.4 Reference Lateral Design Values: Reference lateral design values shall be determined in accordance with Section 3.4.2 (for a calculated and confirmation testing evaluation approach) or Section 3.4.3 of this criteria. Tests for lateral resistance shall be in accordance with Section 4.5.

3.4.1 Bending yield strength for all fastener diameters and lengths shall be determined by tests in accordance with Section 4.4. The average bending yield strength of the tested fasteners shall not exceed the specified minimum bending yield strength by more than 10 percent.

3.4.2 This section is applicable to connections where the side plate is wood or steel and where the lateral design values are determined by calculation and confirmed by testing. The calculated reference design value shall be determined using the yield limit equations found in NDS Section 11.3.1 or by the general dowel equations in AF&PA's Technical Report 12, Table 1, using the following assumptions:

1. The R_d term shall be determined in accordance with the NDS.

2. The following fastener diameters shall be used:

Equations found in the NDS shall assume a diameter equal to the minor diameter at the threads.

Equations found in Technical Report 12 shall assume a diameter equal to the minor diameter at the threads except the diameter used to calculate q_s in Table 1. This diameter can be either the shank diameter or the minor diameter at the threads as evaluated. If the shear plane is in the threads, the minor diameter shall be used.

3. For steel side plate connections, the calculated Mode IV yield value shall be permitted to be used to determine the calculated allowable value where Mode IV yielding is observed during the test and the steel side plate is at least as thick as the tested steel side plate.

4. For steel side plate connections, the steel dowel bearing strength, F_{es}, shall be permitted to be taken as $2.4F_u/1.6$ for hot rolled steel plate specified in the Specification for Structural Steel Building (ANSI/AISC 360), or $2.2F_u/1.6$ for cold-formed steel specified in the North American Specification for the Design of Cold-Formed Steel Structural Members (AISI S100).

5. Wood properties shall be in accordance with the NDS.

6. The dowel bearing length shall be determined per Section 11.3.4 of the NDS. *D* shall be taken as the shank diameter.

The reference lateral design value shall be taken as the lesser of the calculated value or the average ultimate test value divided by 3.2.

3.4.3 This section is applicable to connections where the side plate is wood or steel and where the lateral design values are determined solely by testing. The reference lateral design value may exceed the calculated capacity used based on Section 3.4.2 in this criteria, when the reference design value is taken as the average ultimate test value divided by 5.

3.4.4 If the yield point of the steel from which the tested steel side plate is formed is larger than the specified value, the test results shall be adjusted downward by a factor, R_s, determined from the following equation:

$$R_s = \left(\frac{3.0}{2.5}\right)\left(\frac{Fu-spec}{Fu-tested}\right)\left(\frac{t-spec}{t-tested}\right) \le 1.0$$

where:

R_s = Steel ratio.

(F_u–*spec*) = Published ultimate strength of the side plate steel, psi.

(F_u–*tested*) = Measured ultimate strength of the side plate steel used in the test, psi.

(*t*–*spec*) = Specified minimum side plate thickness, inch.

(*t*–*tested*) = Measured thickness of tested side plate thickness, inch.

3.5 Combined Lateral and Withdrawal Load Design Values: Combined lateral and withdrawal load design values shall conform to Section 11.4 of the NDS.

3.6 Adjustment of Reference Design Values:

3.6.1 For fasteners intended for connections in wood that is exposed to wet service conditions in use, wet service factors (C_m) for the connections shall be established by comparing the results of withdrawal and lateral fastener tests specified in Sections 4.3 and 4.5, respectively, for green (greater than 19 percent moisture content) versus dry (10 to 14 percent moisture content) wood samples. The wet service factor shall be determined as the ratio of average test values of green and dry samples for each specific gravity. In no case shall the wet service factor be greater than specified in Table 10.3.3 of the NDS.

3.6.2 Minimum end and edge distances shall be derived from the load tests of Sections 3.3 and 3.4. Alternatively, confirmatory tests may be run to establish end and edge distance criteria. These tests shall be in accordance with Sections 3.3 and 3.4. In no case shall the edge and end distances be less than specified in Table C11.4-7 of the NDS Commentary for fasteners with shank diameters less than $^1/_4$ inch, or less than minimum values specified in NDS Tables 11.5.1A through E for fasteners with shank diameters equal to or greater than $^1/_4$ inch.

3.6.3 Multiple fastener design values shall conform to Section 11.6 of the NDS.

3.7 Fastener Pull-through: Fastener pull-through testing shall be conducted in accordance with Section 4.6. Alternatively, if the fastener has a straight, nontapered shank that extends to an integral washer head, the pull-through may be calculated using bearing provisions set forth in Section 3.10 of the NDS.

4.0 TEST METHODS

4.1 General:

4.1.1 All wood samples shall be of clear, straight-grained material. The specific gravity and wood species of the wood materials shall be determined in accordance with ASTM D 2395. The moisture content of the wood samples shall be determined in accordance with ASTM D 4442 or D 4444 (handheld moisture meters).

4.1.2 Wood samples shall be conditioned to reach equilibrium with a moisture content of 10 to 14 percent when testing for dry in-service conditions. When testing for wet in-service conditions, samples shall be conditioned to an equilibrium moisture content greater than 19 percent.

4.2 Fastener Metal Strength: Tensile and shear tests of fasteners shall be conducted in accordance with AISI S904-08 (Standard Test Methods for Determining the Tensile and Shear Strength of Screws). Alternatively, shear tests of fasteners may be conducted in accordance with NASM1312-20. A minimum number of samples shall be tested to achieve a precision of 5 percent at 95 percent confidence interval, with a minimum sample size of 10 (refer to ASTM D 2915).

4.3 Withdrawal Load Test: Fastener pullout strength shall be tested in accordance with ASTM D 1761. Each sample shall have the same embedment length. A minimum number of samples shall be tested to achieve a precision of 5 percent at a 75 percent confidence level, with a minimum sample size of 15 specimens and a maximum sample size of 40 specimens. Alternatively, a minimum of 10 specimens may be tested, provided a precision of 5 percent at a 95 percent confidence level is achieved.

4.4 Bending Yield Strength: The bending yield strength of fasteners shall be determined in accordance with ASTM F 1575, and the following:

4.4.1 The 5 percent diameter bending yield strength shall be defined by the section at the minor thread diameter.

4.4.2 The fastener shall be placed on the cylindrical bearing points for testing so that the transition zone between shank and thread is as close as possible to the midpoint between the bearing points, with the load applied at the transition or in the threaded section.

4.4.3 The fastener designation, overall length, length of thread, minor thread diameter, and bending yield strengths shall be recorded.

4.5 Lateral Load Testing: Lateral resistance and fastener slip shall be tested in accordance with ASTM D 1761, and the following:

4.5.1 Friction between the main and side members shall be minimized by the use of a friction-reducing barrier. Alternatively, fasteners shall be inserted to a “tightness” that permits the wood members of the test assembly to rotate relative to each other with only mild pressure.

4.5.2 The sample size for the lateral load tests shall be sufficient when the tested maximum loads have reached a consistency to achieve a precision of 5 percent at a 75 percent confidence level, with a minimum sample size of 15 specimens and a maximum sample size of 40 specimens. Alternatively, a minimum of 10 specimens may be tested, provided a precision of 5 percent at a 95 percent confidence level is achieved.

4.6 Pull-through Test: Fastener pull-through capacity shall be tested by means of a test setup in which the fastener installed in the side member is pulled through. Modifications of the test procedure for fastener withdrawal described in ASTM D 1037 may be used. A minimum number of samples shall be tested to achieve a precision of 5 percent at a 75 percent confidence level, with a minimum sample size of 15 specimens and a maximum sample size of 40 specimens. Alternatively, a minimum of 10 specimens may be tested, provided a precision of 5 percent at a 95 percent confidence level is achieved. If the fastener is to be used with sheathing, the sheathing types for which recognition is sought shall also be tested for pull-through. The mean ultimate fastener pull-through capacity shall be determined for each minimum wood side member thickness, fastener diameter and the targeted wood species/specific gravity, and divided by a factor of 5.

5.0 QUALITY CONTROL

5.1 Documentation complying with the ICC-ES Acceptance Criteria for Quality Documentation (AC10) shall be submitted.

5.2 Third-party follow-up inspections are required under this acceptance criteria.

6.0 EVALUATION REPORT RECOGNITION

6.1 The evaluation report shall include tables similar to those shown in this acceptance criteria. Tables shall be prepared by a registered design professional in accordance with Section 4.1 of the ICC-ES Rules of Procedure for Evaluation Reports.

6.1.1 There shall be a table providing fastener specifications. Refer to Table 1 for an example.

6.1.2 There shall be a table providing withdrawal design values (*W*). Refer to Table 2 for an example.

6.1.3 There shall be a table providing reference lateral design values (*Z*) for single shear (two-member) connections. Refer to Table 3 for connections consisting of two wood members having identical specific gravity, and Table 4 for connections consisting of one wood member and one steel side plate member.

6.2 The evaluation report shall include the allowable fastener metal strength determined in accordance with Section 4.2.

6.3 The evaluation report shall include the following statements:

6.3.1 "When the capacity of a connection is controlled by fastener or steel side plate metal strength, rather than wood strength, the metal strength is not permitted to be multiplied by the adjustment factors specified in the NDS."

6.3.2 "When designing a connection, the structural members must be checked for load-carrying capacity in accordance with Section 10.1.2 of the NDS, and local stresses within the connection must be checked against Appendix E in the NDS to ensure the capacity of the connection and fastener group." ■

TABLE 1—FASTENER SPECIFICATIONS

FASTENER DESIGNATION	OVERALL LENGTH[1] (inches)	LENGTH OF THREAD[2] (inches)	MINOR THREAD DIAMETER[3] (inches)	SHANK DIAMETER[3] (inches)	OUTSIDE THREAD DIAMETER[3] (inches)	ALLOWABLE STEEL STRENGTH		
						Bending Yield Strength[4], F_{yb} (psi)	Tension (pounds)	Shear (pounds)

For **SI:** 1 inch = 25.4 mm; 1 psi = 6.9 kPa.

[1]For purposes of measuring overall fastener length, countersinking type shall be measured from top of head to bottom of tip. Washer type shall be measured from underside of head to bottom of tip.
[2]*Length of thread includes tip. **Length of thread excludes tip. See detailed illustration.
[3]Minor thread, shank and outside thread diameters are shown in table with manufacturing tolerances in brackets [ ].
[4]Bending yield strength determined in accordance with ASTM F 1575 using the minor thread diameter.

TABLE 2— REFERENCE WITHDRAWAL DESIGN VALUES (*W*)[1]
Tabulated Withdrawal Design Values (*W*) Are in Pounds per Inch of Thread Penetration into Side Grain of Main Member

FASTENER DESIGNATION	THREAD LENGTH[2], *L* (inch)	*W* (lbs./in.) FOR SPECIFIC GRAVITIES OF:						
		0.67	0.55	0.5	0.46	0.43	0.36	0.31

For **SI:** 1 inch = 25.4 mm; 1 lbf/in = 175.13 N/m.

[1]Values shall be multiplied by all applicable adjustment factors (see NDS).
[2]Reference withdrawal design values are to be multiplied by the length of thread penetration in the main member. *Length includes tapered tip. **Length excludes tapered tip.

TABLE 3— REFERENCE LATERAL DESIGN VALUES (*Z*) FOR SINGLE SHEAR (TWO-MEMBER) CONNECTIONS[1]
For Sawn Lumber or SCL with Both Members of Identical Specific Gravity

FASTENER DESIGNATION	SIDE MEMBER THICKNESS, t_s (inch)	FASTENER PENETRATION[2], p (inch)	REFERENCE LATERAL DESIGN VALUE (*Z*) FOR SPECIFIC GRAVITIES OF: (pounds)						
			0.67	0.55	0.5	0.46	0.43	0.36	0.31
			$Z_\parallel$ $Z_{\perp s}$ $Z_{\perp m}$ $Z_\perp$	$Z_\parallel$ $Z_{\perp s}$ $Z_{\perp m}$ $Z_\perp$	$Z_\parallel$ $Z_{\perp s}$ $Z_{\perp m}$ $Z_\perp$	$Z_\parallel$ $Z_{\perp s}$ $Z_{\perp m}$ $Z_\perp$	$Z_\parallel$ $Z_{\perp s}$ $Z_{\perp m}$ $Z_\perp$	$Z_\parallel$ $Z_{\perp s}$ $Z_{\perp m}$ $Z_\perp$	$Z_\parallel$ $Z_{\perp s}$ $Z_{\perp m}$ $Z_\perp$

For **SI:** 1 inch = 25.4 mm.

[1]Values shall be multiplied by all applicable adjustment factors (see NDS).
[2]For 1997 UBC and 2000 IBC/IRC values: when penetration, *p*, into the main member is less than 8*D* (*D* = shank diameter) the values in the table shall be multiplied by the following penetration depth factor: $C_d = P/(8D) \leq 1.0$.

TABLE 4—REFERENCE LATERAL DESIGN VALUES (*Z*) FOR SINGLE SHEAR (TWO-MEMBER) CONNECTIONS[1]
with Steel Side Plate

FASTENER DESIGNATION	SIDE MEMBER THICKNESS, t_s (inch)	FASTENER PENETRATION[2], p (inch)	REFERENCE LATERAL DESIGN VALUE (Z) FOR SPECIFIC GRAVITIES OF: (pounds)						
			0.67	0.55	0.5	0.46	0.43	0.36	0.31
			$Z_\parallel$ $Z_\perp$	$Z_\parallel$ $Z_\perp$	$Z_\parallel$ $Z_\perp$	$Z_\parallel$ $Z_\perp$	$Z_\parallel$ $Z_\perp$	$Z_\parallel$ $Z_\perp$	$Z_\parallel$ $Z_\perp$

For **SI:** 1 inch = 25.4 mm.

[1]Values shall be multiplied by all applicable adjustment factors (see NDS).
[3]Minimum steel side plate tensile strength F_u = __ ksi.
[2]"For 1997 UBC and 2000 IBC/IRC values: when penetration, *p*, into the main member is less than 8*D* (*D* = shank diameter) the values in the table shall be multiplied by the following penetration depth factor: $C_d = P/(8D) \leq 1.0$.

TABLE 5—PULL-THROUGH DESIGN VALUES (*P*) [1, 2]

FASTENER DESIGNATION	MINIMUM SIDE MEMBER THICKNESS (inches)	*P* (lbs.) FOR SPECIFIC GRAVITIES OF:						
		0.67	0.55	0.5	0.46	0.43	0.36	0.31

For **SI:** 1 inch = 25.4 mm.

[1]Values shall be multiplied by all adjustment factors, as applicable to reference withdrawal design values, W, in accordance with the NDS.