DrJ CERTIFICATION

Approved. Sealed. Code Compliant.

Technical Evaluation Report

TER 1908-02

BareNaked Tstud™

US Engineered Wood, Inc.

Product:

BareNaked Tstud™ Structural Wall Stud

Issue Date:

July 31, 2020

Revision Date:

July 31, 2020

Subject to Renewal:

October 1, 2021

COMPANY INFORMATION:

US Engineered Wood, Inc.

14048 Terrace Rd NE
Ham Lake, MN 55304-6746

612-978-8011

sales@tstud.com

www.tstud.com

DIVISION: 06 00 00 - WOOD, PLASTICS AND COMPOSITES

SECTION: 06 10 00 - Rough Carpentry

1 PRODUCT EVALUATED[1]

1.1 BareNaked Tstud™ Structural Wall Stud

2 APPLICABLE CODES AND STANDARDS[2,3]

2.1 *Codes*

2.1.1 *IBC—12, 15, 18: International Building Code®*

2.1.2 *IRC—12, 15, 18: International Residential Code®*

2.2 *Standards and Referenced Documents*

2.2.1 *ANSI/AWC NDS: National Design Specification (NDS) for Wood Construction*

2.2.2 *ASCE/SEI 7: Minimum Design Loads and Associated Criteria for Buildings and Other Structures*

2.2.3 *ASTM D198: Standard Test Methods of Static Tests of Lumber in Structural Sizes*

2.2.4 *ASTM D2559: Standard Specification for Adhesives for Bonded Structural Wood Products for Use Under Exterior Exposure Conditions*

[1] Building codes require data from valid research reports be obtained from *approved sources*. Agencies who are accredited through ISO/IEC 17065 have met the code requirements for approval by the *building official*. DrJ is an ISO/IEC 17065 ANSI-Accredited Product Certification Body – Accreditation #1131.

Through ANSI accreditation and the IAF MLA, DrJ certification can be used to obtain product approval in any *jurisdiction* or country that has IAF MLA Members & Signatories to meet the Purpose of the MLA – "certified once, accepted everywhere."

Building official approval of a licensed *registered design professional* (RDP) is performed by verifying the RDP and/or their business entity complies with all professional engineering laws of the relevant *jurisdiction*. Therefore, the work of licensed RDPs is accepted by *building officials*, except when plan (i.e. peer) review finds an error with respect to a specific section of the code. Where this TER is not approved, the *building official* responds in writing stating the reasons for disapproval.

For more information on any of these topics or our mission, product evaluation policies, product approval process, and engineering law, visit drjcertification.org or call us at 608-310-6748.

[2] Unless otherwise noted, all references in this TER are from the 2018 version of the codes and the standards referenced therein (e.g., *ASCE 7, NDS, ASTM*). This material, design, or method of construction also complies with the 2000-2015 versions of the referenced codes and the standards referenced therein.

[3] All terms defined in the applicable building codes are italicized.

3 PERFORMANCE EVALUATION

3.1 BareNaked Tstud™ was evaluated for the following:

3.1.1 Use as an alternative material where nominal 2″x4″ solid sawn lumber is specified in accordance with the *IBC* and *IRC* for use as wall studs, top plates, and bottom plates.

3.1.2 Use as an alternative material to that described in *IBC* Chapter 23, in particular, compliance with requirements for the design and construction of wood-based products as described in *IBC* Section 2301.2 for allowable stress design (ASD).

3.1.3 Compliance with *IBC* Section 2308 and Section 2304 and *IRC* Chapter 6 for conventional light-frame construction applications.

3.1.4 Use as an alternative material and method of construction in compliance with *IBC* Section 104.11 and *IRC* Section R104.11.

3.2 BareNaked Tstud™ testing and analysis was conducted to determine its flexural strength and stiffness.

3.3 Where the application exceeds the limits of *IBC* Section 2308 or *IRC* Section R301, an engineered design shall be submitted in accordance with *IRC* Section R301.1.3 and this TER.

3.4 The insulation used with BareNaked Tstuds™ is outside the scope of this TER.

3.5 Any code compliance issues not specifically addressed in this section are outside the scope of this TER.

3.6 Any engineering evaluation conducted for this TER was performed on the dates provided in this TER and within DrJ's professional scope of work.

4 PRODUCT DESCRIPTION AND MATERIALS

4.1 The product evaluated in this TER is shown in Figure 1 and Figure 2.

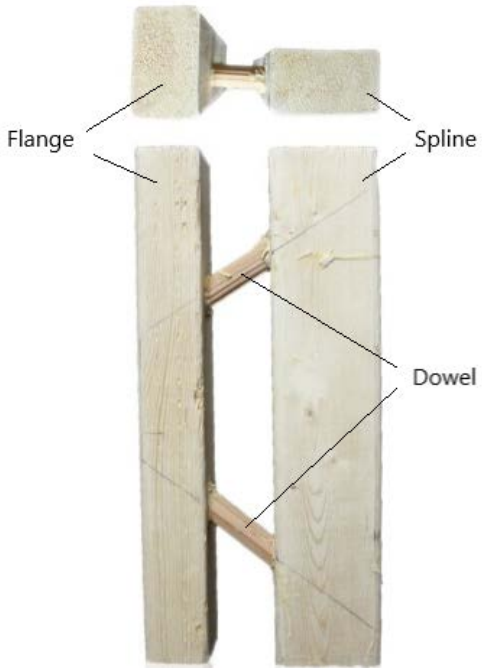

FIGURE 1. BARENAKED TSTUD™

FIGURE 2. BARENAKED TSTUD™ LABEL

4.2 BareNaked Tstud™ is made from a minimum of nominal 2″x3″ No. 2 Spruce Pine Fir (SPF) lumber and wooden dowels.

4.2.1 The overall size of BareNaked Tstud™ is 2½″ x 5½″.

4.2.2 The BareNaked Tstud™ is composed of two 2″x3″ sawn lumber members (flange and spline) with wooden dowel connectors between the members. The flange and spline are oriented perpendicular to one another to form an L-shape. The dowels are connected to the flange and spline with adhesive.

4.2.3 Dowels are spaced evenly at a distance not to exceed 6½″ on center and glued in place using an adhesive that conforms to the specifications of *ASTM D2559*.

4.2.4 Any lumber species can be used, as long as the design values of the lumber are equal to or greater than No. 2 SPF.

4.3 *Minimum Materials*

4.3.1 *Lumber:*

4.3.1.1 Grade: No. 2 SPF

4.3.1.2 Thickness: 1½″ (38 mm)

4.3.1.3 Width: 2½″ (64 mm)

4.3.1.4 Length: up to 14' (4.3 m)

4.3.2 *Dowels:*

4.3.2.1 Grade: No. 2 SPF

4.3.2.2 Diameter: $^{11}/_{16}$″ (17.5 mm)

5 APPLICATIONS

5.1 *Prescriptive Provisions*

5.1.1 BareNaked Tstud™ is an alternative to solid sawn 2″x4″ lumber for wall structural members.

5.1.1.1 For use as a 2″x6″, design shall be permitted in accordance with accepted engineering procedures, experience, and technical judgment. In these cases, referenced design values as specified in Table 2 shall be used in accordance with *IBC* Section 2308 and *IRC* Section R602.

5.1.2 BareNaked Tstud™ used as wall framing members shall be fastened as specified in Table 1.

TABLE 1. ACCEPTABLE FASTENING SCHEDULE FOR BARENAKED TSTUD™

Application	Number & Type of Fastener	Fastener Spacing (in.)	Installation[1]
Ceiling joists to top plate (toe nail)	3 (4″ x 0.131″)	-	Fasten two (2) toe nails into interior flange/spline and one (1) toe nail into exterior flange/spline
Rafter or roof truss to plate (toe nail)	3 (3½″ x 0.135″)	-	Two (2) toe nails on one side and one (1) toe nail on opposite side of each rafter or truss
	4 (4″ x 0.131″)		Fasten two (2) toe nails into interior flange/spline and two (2) toe nails into exterior flange/spline
Built-up studs (face nail through flange[2])	(4″ x 0.131″)	16 o.c.	Fasten two (2) face nails, one (1) into each flange/spline
Built-up studs (face nail through spine[3])	(3″ x 0.131″)	16 o.c.	Fasten two (2) face nails, one (1) into each flange/spline
Abutting studs at intersecting wall corners (face nail)	(4″ x 0.131″)	12 o.c.	Fasten one (1) face nail into exterior-facing flange/spline
Double top plates, minimum 24″ offset of end joints, face nail in lapped area	12 (4″ x 0.131″)	-	Fasten twelve (12) face nails on each side of end joint (minimum 24″ lap splice length each side of joint)
Stud to plate (toe nail)	4 (4″ x 0.131″)	-	Fasten two (2) toe nails into sole plate on each side of the stud (each flange/spline)
Plate to stud (end nail)	3 (4″ x 0.131″)	-	Fasten two (2) nails into the flange and one (1) nail into the spline
	2 (4½″ x 0.162″)		Fasten two (2) nails, one (1) into each flange/spline
Top plates, laps at corners and intersections (face nail)	2 (4″ x 0.162″)	-	Fasten two (2) face nails, one (1) into each flange/spline
Rim joist to sill or top plate	(2½″ x 0.113″)	4 o.c.	Fasten by toe-nailing
	(2½″ x 0.131″)	6 o.c.	

SI: 1 in. = 25.4 mm

1. Care must be taken to avoid splitting.
2. The flange of the BareNaked Tstud™ is the 2.5" wide x 1.5" deep side (Figure 1).
3. The spline of the BareNaked Tstud™ is the 1.5" wide x 2.5" deep side (Figure 1).

5.1.3 BareNaked Tstud™ may be used as a single top plate in accordance with *IRC* Section R602.3.2 and the following:

5.1.3.1 Fasteners for BareNaked Tstud™ connections shall be distributed in each BareNaked Tstud™ flange and spline (top plate to stud connections shall be fastened using three (3) 4" x 0.131" nails, one (1) into the spline and two (2) into the flange).

5.1.4 Use as jack, trimmer, and cripple studs is permitted.

5.1.4.1 Install cripple studs between the bottom plate and rough sill using three (3) 4" x 0.131" nails, one (1) into the spline and two (2) into the flange.

5.1.5 Structural sheathing shall be installed on one side of the wall and fastened in accordance with the applicable building code.

5.1.6 Trusses and rafters placed on BareNaked Tstud™ wall studs with a single BareNaked Tstud™ (or No. 2 SPF) top plate must meet the following:

5.1.6.1 Maximum reaction of 3,665 lbs.

5.1.6.2 Maximum wall height of 11 ft.

5.1.6.3 Maximum stud spacing of 24" o.c.

5.1.7 Trusses and rafters placed on BareNaked Tstuds™ wall studs with a single Southern Pine (SP) top plate must meet the following:

5.1.7.1 Maximum reaction of 4,875 lbs.

5.1.7.2 Maximum wall height of 9 ft.

5.1.7.3 Maximum stud spacing of 24" o.c.

5.1.8 For wall assemblies with top and bottom plates of other wood products or species, an engineering design is required.

5.2 *Engineered Design*

5.2.1 The design provisions for wood construction noted in *IBC* Section 2302.1[4] and *IRC* Section R301.1.3 apply to BareNaked Tstud™ for allowable stress design (ASD), unless otherwise noted in this TER.

5.2.2 Design of connections using BareNaked Tstud™ shall be in accordance with *NDS*.

5.2.3 *Material Properties*

5.2.3.1 Reference design values for BareNaked Tstud™ are specified in Table 2.

5.2.3.1.1 Reference design values for BareNaked Tstud™ shall be multiplied by the adjustment factors specified in *NDS* Section 4.3.

TABLE 2. BARENAKED TSTUD™ REFERENCE DESIGN VALUES

Reference Design Value	BareNaked Tstud™ (No. 2 SPF)
Bending, F_bS	660 lb-ft
Compression Parallel to Grain, F_c	1,150 psi
Tension Parallel to Grain, F_t	450 psi
Compression Perpendicular to Grain, $F_{c\perp}$	425 psi
Shear Force, V	260 lbs.
Bending Stiffness, EI	19,252,000 lb-in^2
Bending Stiffness for Beam and Column Stability, EI_{min}	8,615,000 lb-in^2
SI: 1 in. = 25.4 mm, 1 lb. = 4.45 N, 1 psi = 0.00689 MPa	

5.2.4 *Design for Compression Loads*

5.2.4.1 The maximum allowable compression load for walls framed with BareNaked Tstud™ studs is specified in Table 3.

5.2.4.2 The maximum allowable compression load is based on perpendicular-to-grain crushing of SPF top and bottom plates and compression parallel to grain of the BareNaked Tstud™.

5.2.4.3 The allowable axial compression for BareNaked Tstud™ can be calculated using the provisions of *NDS* Section 3.6 and 3.7.

5.2.4.4 For computing the column stability factor, C_P, the critical bucking design value, F_{cE}, shall be computed using Equation 1.

[4] 2015 *IBC* Section 2301.2

EQUATION 1. CRITICAL BUCKLING DESIGN VALUE

$$F_{cE} = \frac{\pi^2 * EI_{min}}{A * (l_e)^2}$$

Where: EI_{min} = bending stiffness for beam and column stability (lb-in^2)

A = minimum net section area of BareNaked Tstud™ (in^2) = (1.5″ x 2.5″) + ((1.5″ – 0.6875″) x 2.5″) = 5.78 in^2

l_e = Effective column length (in.) = K_e x h

TABLE 3. ALLOWABLE COMPRESSIVE LOAD FOR WALLS FRAMED WITH BARENAKED TSTUD™ [1]

Stud Height (ft.)	Allowable Compressive Load (lbs.)	
	Top/Bottom Plate	
	BareNaked Tstud™ (SPF) (SG = 0.42)[2]	Southern Pine (SP) (SG = 0.55)[3]
8	3,665	4,875
9	3,665	4,875
10	3,665	4,750
11	3,665	4,175
12	3,660	3,660
13	3,210	3,210
14	2,825	2,825

SI: 1 in. = 25.4 mm, 1 lb. = 4.45 N

1. Compression perpendicular to grain is assumed to be 425 psi for the BareNaked Tstud™ and 565 psi for SP (adjusted per *NDS* Section 3.10.4).
2. Compression perpendicular to grain of the BareNaked Tstud™ top and bottom plates controls for walls less than or equal to 11 ft. in height.
3. Compression perpendicular to grain of the SP top and bottom plates controls for walls less than or equal to 9 ft. in height.

5.2.5 *Design for Bending*

5.2.5.1 The maximum bending moment and shear forces shall not exceed the reference design values for the BareNaked Tstud™ specified in Table 2.

5.2.6 *Design for Combined Bending and Axial Compression Loads*

5.2.6.1 The BareNaked Tstud™ resists bending using tension and compression stresses in the flange and spline.

5.2.6.2 The axial compressive stress due to combined bending and axial load can be computed using Equation 2.

EQUATION 2. AXIAL COMPRESSIVE STRESS

$$f_a = \frac{P}{A} + \frac{M}{A_m * d_{eff}}$$

Where: P = axial load applied to BareNaked Tstud™ (lb)

A = minimum net section area of BareNaked Tstud™ (in^2) = (1.5″ x 2.5″) + ((1.5″ – 0.6875″) x 2.5″) = 5.78 in^2

M = bending moment applied to BareNaked Tstud™ (lb-in)

A_m = minimum net section area of single BareNaked Tstud™ member (in^2) = ((1.5″ – 0.6875″) x 2.5″) = 2.03 in^2

d_{eff} = distance from center to center of BareNaked Tstud™ member (in) = 3.5 in

5.2.6.3 The axial stresses in BareNaked Tstud™ member shall be checked in accordance with *NDS* Section 3.6 and 3.7.

5.2.6.4 BareNaked Tstud™ shall also be checked in bending only to ensure the allowable bending moment in Table 2 is not exceeded.

5.2.6.5 Allowable wind pressures for BareNaked Tstuds™ stud walls with SPF top and bottom plates subject to axial loads are specified in Table 4.

TABLE 4. ALLOWABLE (ASD) COMPRESSIVE LOAD FOR WALLS SUBJECT TO WIND PRESSURES (SPF TOP/BOTTOM PLATES)[1,2]

Stud Spacing (in.)	Wall Height (ft.)	Allowable Compression Load (lbs.) & (Deflection Ratio)									
		Components & Cladding Wind Pressure (psf)									
		15	20	25	30	35	40	45	50	55	60
12	8	3,665 (L/2161)	3,665 (L/1621)	3,665 (L/1297)	3,665 (L/1081)	3,665 (L/926)	3,665 (L/810)	3,665 (L/720)	3,665 (L/648)	3,665 (L/589)	3,665 (L/540)
	9	3,665 (L/1497)	3,665 (L/1123)	3,665 (L/898)	3,665 (L/748)	3,665 (L/641)	3,665 (L/561)	3,325 (L/499)	2,980 (L/449)	2,635 (L/408)	2,290 (L/374)
	10	3,665 (L/1079)	3,665 (L/809)	3,295 (L/647)	2,865 (L/540)	2,435 (L/462)	2,010 (L/405)	1,580 (L/360)	1,155 (L/324)	725 (L/294)	295 (L/270)
	12	2,080 (L/614)	1,460 (L/461)	835 (L/368)	210 (L/307)	-	-	-	-	-	-
	14	400 (L/382)	-	-	-	-	-	-	-	-	-
16	8	3,665 (L/1621)	3,665 (L/1216)	3,665 (L/973)	3,665 (L/810)	3,665 (L/695)	3,665 (L/608)	3,665 (L/540)	3,665 (L/486)	3,610 (L/442)	3,250 (L/405)
	9	3,665 (L/1123)	3,665 (L/842)	3,665 (L/674)	3,665 (L/561)	3,210 (L/481)	2,750 (L/421)	2,290 (L/374)	1,830 (L/337)	1,370 (L/306)	910 (L/281)
	10	3,665 (L/809)	3,150 (L/607)	2,580 (L/486)	2,010 (L/405)	1,440 (L/347)	865 (L/303)	295 (L/270)	-	-	-
	12	1,460 (L/461)	625 (L/345)	-	-	-	-	-	-	-	-
24	8	3,665 (L/1081)	3,665 (L/810)	3,665 (L/648)	3,665 (L/540)	3,665 (L/463)	3,250 (L/405)	2,715 (L/360)	2,175 (L/324)	1,635 (L/295)	1,095 (L/270)
	9	3,665 (L/748)	3,665 (L/561)	2,980 (L/449)	2,290 (L/374)	1,600 (L/321)	910 (L/281)	225 (L/249)	-	-	-
	10	2,865 (L/540)	2,010 (L/405)	1,155 (L/324)	295 (L/270)	-	-	-	-	-	-
	12	210 (L/307)	-	-	-	-	-	-	-	-	-

SI: 1 in. = 25.4 mm, 1 psf = 0.0479 kN/m^2

1. Wind speed provided assumes Exposure Category B, Enclosed Building, Mean Roof Height 30'
2. Walls constructed with BareNaked Tstud™ studs and SPF top and bottom plates.

5.2.6.6 Allowable wind pressures for BareNaked Tstuds™ stud walls with SP top and bottom plates subject to axial loads are specified in Table 5.

TABLE 5. ALLOWABLE (ASD) COMPRESSIVE LOAD FOR WALLS SUBJECT TO WIND PRESSURES (SP TOP/BOTTOM PLATES)[1,2]

Stud Spacing (in.)	Wall Height (ft.)	Allowable Compression Load (lbs.) & (Deflection Ratio)									
		Components & Cladding Wind Pressure (psf)									
		15	20	25	30	35	40	45	50	55	60
12	8	4,875 (L/2161)	4,875 (L/1621)	4,875 (L/1297)	4,875 (L/1081)	4,875 (L/926)	4,875 (L/810)	4,875 (L/720)	4,870 (L/648)	4,600 (L/589)	4,330 (L/540)
	9	4,875 (L/1497)	4,875 (L/1123)	4,700 (L/898)	4,355 (L/748)	4,010 (L/641)	3,670 (L/561)	3,325 (L/499)	2,980 (L/449)	2,635 (L/408)	2,290 (L/374)
	10	4,150 (L/1079)	3,720 (L/809)	3,295 (L/647)	2,865 (L/540)	2,435 (L/462)	2,010 (L/405)	1,580 (L/360)	1,155 (L/324)	725 (L/294)	295 (L/270)
	12	2,080 (L/614)	1,460 (L/461)	835 (L/368)	210 (L/307)	--	--	--	--	--	--
	14	400 (L/382)	--	--	--	--	--	--	--	--	--
16	8	4,875 (L/1621)	4,875 (L/1216)	4,875 (L/973)	4,875 (L/810)	4,875 (L/695)	4,690 (L/608)	4,330 (L/540)	3,970 (L/486)	3,610 (L/442)	3,250 (L/405)
	9	4,875 (L/1123)	4,585 (L/842)	4,125 (L/674)	3,670 (L/561)	3,210 (L/481)	2,750 (L/421)	2,290 (L/374)	1,830 (L/337)	1,370 (L/306)	910 (L/281)
	10	3,720 (L/809)	3,150 (L/607)	2,580 (L/486)	2,010 (L/405)	1,440 (L/347)	865 (L/303)	295 (L/270)	--	--	--
	12	1,460 (L/461)	625 (L/345)	--	--	--	--	--	--	--	--
24	8	4,875 (L/1081)	4,875 (L/810)	4,870 (L/648)	4,330 (L/540)	3,790 (L/463)	3,250 (L/405)	2,715 (L/360)	2,175 (L/324)	1,635 (L/295)	1,095 (L/270)
	9	4,355 (L/748)	3,670 (L/561)	2,980 (L/449)	2,290 (L/374)	1,600 (L/321)	910 (L/281)	225 (L/249)	--	--	--
	10	2,865 (L/540)	2,010 (L/405)	1,155 (L/324)	295 (L/270)	--	--	--	--	--	--
	12	210 (L/307)	--	--	--	--	--	--	--	--	--

SI: 1 in. = 25.4 mm, 1 psf = 0.0479 kN/m²

1. Wind speed provided assumes Exposure Category B, Enclosed Building, Mean Roof Height 30'
2. Walls constructed with BareNaked Tstud™ studs and SP top and bottom plates.

5.3 For applications outside the scope of this applicable code, consult the manufacturer's installation instructions or a professional engineer registered in the state of the project.

5.4 Where the application exceeds the limitations set forth herein, design shall be permitted in accordance with accepted engineering procedures, experience, and technical judgment.

6 INSTALLATION

6.1 BareNaked Tstud™ shall be installed in accordance with the applicable code, the approved construction documents, this TER, the manufacturer's installation instructions, *NDS,* and otherwise standard framing practices as applied to solid-sawn lumber. In the event of a conflict between the manufacturer's installation instructions and this TER, the more restrictive shall govern.

6.2 *Installation Procedure*

6.2.1 BareNaked Tstud™ is pre-assembled and designed to be used as a direct replacement of nominal 2″x4″ solid sawn lumber as wall studs, top plates, and bottom plates.

6.2.2 Install BareNaked Tstud™ in the same manner as solid sawn lumber, except as noted herein.

6.2.2.1 The BareNaked Tstud™ wall stud may be oriented in either direction (i.e., with the flange facing the interior of exterior face of the wall).

6.2.2.2 The BareNaked Tstud™ shall be used as a bottom plate only where the wall is connected to a wood deck. For walls connected to a concrete deck, a solid sawn, treated 2″x6″ member shall be used as the bottom plate.

6.2.2.3 Where BareNaked Tstud™ is used as a top plate, a separate means of fireblocking shall be provided in accordance with Section 9.2.

6.2.3 For *IBC* Section 2308 and the *IRC*, install in accordance with the provisions therein, except as noted in this TER.

6.2.4 See Section 5.1 and Table 1 for prescriptive connection requirements.

6.2.5 *Hold Downs:*

6.2.5.1 Hold-downs shall not be attached directly to BareNaked Tstud™ members. Solid sawn nominal 2″x6″ studs shall be used where hold-downs attach to the wall.

6.2.6 *Drilling and Notching:*

6.2.6.1 Drilling BareNaked Tstuds™ is allowed when in accordance with *IBC* Section 2308.5.9 and Section 2308.5.10 and *IRC* Section R602.6 as shown in Figure 3.

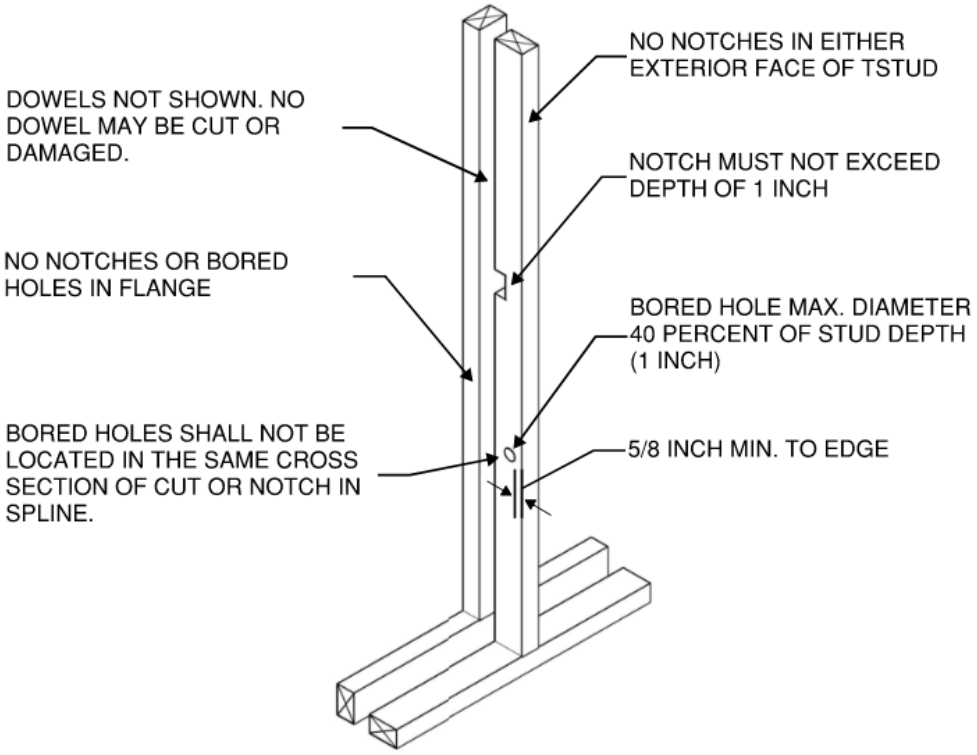

FIGURE 3. DRILLING AND NOTCHING OF BARENAKED TSTUDS™

6.2.6.2 No dowels may be cut or damaged.

6.2.6.3 Notches on the exterior faces of the flange and spline are not permitted.

7 TEST ENGINEERING SUBSTANTIATING DATA

7.1 Bending tests in accordance with *ASTM D198* conducted by SBCRI

7.2 *ANSI/AWC NDS: National Design Specification (NDS) for Wood Construction*

7.3 Some information contained herein is the result of testing and/or data analysis by other sources which conform to *IBC* Section 1703 and relevant professional engineering law. DrJ relies on accurate data from these sources to perform engineering analysis. DrJ has reviewed and found the data provided by other professional sources to be credible.

7.4 Where appropriate, DrJ's analysis is based on design values that have been codified into law through codes and standards (e.g., *IBC, IRC, NDS®,* and *SDPWS*). This includes review of code provisions and any related test data that aids in comparative analysis or provides support for equivalency to an intended end-use application. Where the accuracy of design values provided herein is reliant upon the published properties of commodity materials (e.g., lumber, steel, and concrete), DrJ relies upon the grade mark, stamp, and/or design values provided by raw material suppliers to be accurate and conforming to the mechanical properties defined in the relevant material standard.

8 FINDINGS

8.1 When used and installed in accordance with this TER and the manufacturer's installation instructions, the product(s) listed in Section 1.1 are approved for the following:

8.1.1 BareNaked Tstud™ wall studs installed as framing members in walls, as described in this TER, are compliant with the codes listed in Section 2 and are approved for use as an alternative to nominal 2″x4″ (38 mm x 89 mm) solid sawn lumber in all cases for wall structural members.

8.1.2 For use as a 2″x6″ (38 mm x 140 mm), design shall be permitted in accordance with accepted engineering procedures, experience, and technical judgment. In these cases, referenced design values as specified in Table 2 shall be used in accordance with *IBC* Section 2308 and *IRC* Section R602.

8.2 *IBC* Section 104.11 (*IRC* Section R104.11 and *IFC* Section 104.9 are similar) states:

> 104.11 Alternative materials, design and methods of construction and equipment. The provisions of this code are not intended to prevent the installation of any material 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, not less than the equivalent of that prescribed in this code…Where the alternative material, design or method of construction is not *approved*, the *building official* shall respond in writing, stating the reasons the alternative was not *approved*.

8.3 This product has been evaluated in the context of the codes listed in Section 2 and is compliant with all known state and local building codes. Where there are known variations in state or local codes applicable to this evaluation, they are listed here.

8.3.1 No known variations

9 Conditions of Use

9.1 BareNaked Tstud™ complies with, or is a suitable alternative to, sawn lumber as permitted by the codes listed in Section 2 subject to the following conditions:

9.1.1 The maximum wall height for BareNaked Tstud™ is 14' (4.3 m).

9.1.2 Increases for duration of load shall be in accordance with the limitations of the applicable building code for sawn lumber.

9.1.3 Creep factors applicable to sawn lumber may be applied to this product, in accordance with the applicable building code.

9.2 Notches in the exterior faces of the BareNaked Tstud™ (flange and spline) are not permitted (Figure 3).

9.3 No dowels may be cut or damaged (Figure 3).

9.4 Where BareNaked Tstud™ is used as a top plate, a separate means of fireblocking shall be provided in accordance with *IBC* Section 718 and *IRC* Section R302.11.

9.5 Where required by the *building official*, also known as the authority having jurisdiction (AHJ) in which the project is to be constructed, this TER and the installation instructions shall be submitted at the time of *permit* application.

9.6 Any generally accepted engineering calculations needed to show compliance with this TER shall be submitted to the AHJ for review and approval.

9.7 Design loads shall be determined in accordance with the building code adopted by the *jurisdiction* in which the project is to be constructed and/or by the Building Designer (e.g., *owner* or *registered design professional*).

9.8 At a minimum, this product shall be installed per Section 6 of this TER.

9.9 This product is manufactured under a third-party quality control program in accordance with *IBC* Section 104.4 and 110.4 and *IRC* Section R104.4 and R109.2.

9.10 The actual design, suitability, and use of this TER, for any particular building, is the responsibility of the *owner* or the owner's authorized agent. Therefore, the TER shall be reviewed for code compliance by the *building official* for acceptance.

9.11 The use of this TER is dependent on the manufacturer's in-plant QC, the ISO/IEC 17020 third-party quality assurance program and procedures, proper installation per the manufacturer's instructions, the *building official's* inspection, and any other code requirements that may apply to demonstrate and verify compliance with the applicable building code.

10 IDENTIFICATION

10.1 The product(s) listed in Section 1.1 are identified by a label on the board or packaging material bearing the manufacturer's name, product name, TER number, and other information to confirm code compliance.

10.2 Additional technical information can be found at www.tstud.com.

11 REVIEW SCHEDULE

11.1 This TER is subject to periodic review and revision. For the most recent version of this TER, visit drjcertification.org.

11.2 For information on the current status of this TER, contact DrJ Certification.

APPENDIX A: BARENAKED TSTUD™ EXAMPLE CALCULATION

Determine the allowable axial load for an 10' BareNaked Tstud™ of No. 2 SPF lumber spaced 16" o.c. and subject to wind speeds of 140 mph.

Material Properties of BareNaked Tstud™:

The material properties of the BareNaked Tstud™ are given in Table 2 of the TER.

$F_bS := 660\ lbf \cdot ft$	Bending
$F_c := 1150\ psi$	Compression Parallel to Grain
$F_t := 450\ psi$	Tension Parallel to Grain
$F_{c\_perp} := 425\ psi$	Compression Perpendicular to Grain
$V_n := 260\ lbf$	Shear Force
$EI := 19252000\ lbf \cdot in^2$	Bending Stiffness
$EI_{min} := 8615000\ lbf \cdot in^2$	Bending Stiffness for Beam and Column Stability
$C_{fc} := 1.15$ $C_{ft} := 1.5$	Size factors for 2x3 lumber.

Section Properties of BareNaked Tstud™:

$w := 5.5\ in$	Overall width
$d_1 := 1.5\ in$	Wide face dimension
$d_2 := 2.5\ in$	Narrow face dimension
$d_{dowel} := \frac{11}{16}\ in$	Dowel diameter
$d_{eff} := w - \left(\frac{d_1}{2}\right) - \left(\frac{d_2}{2}\right) = 3.5\ in$	Moment arm between members
$A_{net} := (d_1 \cdot d_2) + ((d_1 - d_{dowel}) \cdot d_2) = 5.78\ in^2$	Net section area of BareNaked Tstud™, NDS Section 3.6.3 and Section 3.1.2.1
$h := 116.125\ in = 10\ ft$	Height of BareNaked Tstud™

Compression Capacity of BareNaked Tstud™ under Vertical Load only:

$C_D := 1.0$	Load Duration Factor for Occupancy Live Load, NDS Table 2.3.2
$F_{c.star} := F_c \cdot C_{fc} \cdot C_D = 1323\ psi$	Reference compression design value multiplied by all adjustment factors except Cp
$A_b := 2 \cdot d_1 \cdot d_2 = 7.5\ in^2$	Net bearing area of BareNaked Tstud™

$c := 0.8$ — Constant for sawn lumber, NDS Section 3.7.1

$K := 1.0$ — Buckling effective length factor for pinned-pinned column.

$l_e := K \cdot h = 10\ ft$ — Effective column length

$F_{cE} := \frac{\pi^2\ EI_{min}}{A_{net} \cdot l_e^{\ 2}} = 1091\ psi$ — Critical buckling design value, TER Equation 1

$$C_P := \frac{1 + \left(\frac{F_{cE}}{F_{c.star}}\right)}{2 \cdot c} - \sqrt{\left(\frac{1 + \left(\frac{F_{cE}}{F_{c.star}}\right)}{2 \cdot c}\right)^2 - \frac{\left(\frac{F_{cE}}{F_{c.star}}\right)}{c}} = 0.621$$

Column stability factor, NDS Section 3.7.1.5

$F'_c := F_{c.star} \cdot C_P = 821\ psi$ < $F_{cE} = 1091\ psi$ OK

$P_{buckling} := F_{c.star} \cdot C_P \cdot A_b = 6160\ lbf$ — Force, Buckling

$C_b := \frac{d_2 + 0.375\ in}{d_2} = 1.15$ — Bearing Area Factor, NDS Section 3.10.4

$P_{comp\_perp} := F_{c\_perp} \cdot C_b \cdot A_b = 3666\ lbf$ — Force, Compression Perpendicular

Bending Capacity of BareNaked Tstud™:

$C_D := 1.6$ — Load Duration Factor

$A_{eff} := h \cdot \frac{h}{3} = 31\ ft^2$ — Effective wind area for a single BareNaked Tstud™

$p_{pos} := 20.2\ psf$
$p_{neg} := -26.0\ psf$ — Wind pressures for a basic wind speed, Vult, of 140 mph, mean roof height of 30 ft, and Exposure B per IRC Table R301.2(2)

$S_{stud} := 16\ in$ — Stud spacing

$w := \left(-p_{neg}\right) \cdot S_{stud} = 34.7\ plf$

$M_{req'd} := \frac{w \cdot h^2}{8} = 4870\ lbf \cdot in$ < $M_{all} := F_b S \cdot C_D = 12672\ lbf \cdot in$

Check shear load:

$V_{req'd} := \frac{w \cdot h}{2} = 168\ lbf$ < $V_{all} := V_n \cdot C_D = 416\ lbf$ OK

Combined Axial Load and Component & Cladding Wind Load on BareNaked Tstud™:

$C_D := 1.6$ — Load Duration Factor

$F_{c.star} := F_c \cdot C_{fc} \cdot C_D = 2116\ psi$ — Reference compression design value multiplied by all adjustment factors except Cp

$$C_P := \frac{1+\left(\frac{F_{cE}}{F_{c.star}}\right)}{2 \cdot c} - \sqrt{\left(\frac{1+\left(\frac{F_{cE}}{F_{c.star}}\right)}{2 \cdot c}\right)^2 - \frac{\left(\frac{F_{cE}}{F_{c.star}}\right)}{c}} = 0.444$$

Column stability factor, NDS Section 3.7.1.5

$F_c' := F_{c.star} \cdot C_P = 940\ psi$

Check combined bending and compression on the member:

$A_m := \left(d_1 - d_{dowel}\right) \cdot d_2 = 2.03\ in^2$

$M_{applied} := \frac{0.75\ w \cdot h^2}{8} = 3652\ lbf \cdot in$ — A 0.75 factor is applied to the wind load in accordance with load combination 6a in ASCE 7 Section 2.4.1.

$P := 2465\ lbf$ — Axial load on the BareNaked Tstud™ is selected to result in a CSI of 1.0.

$f_a := \frac{P}{A_{net}} + \frac{M_{applied}}{A_m \cdot d_{eff}} = 940\ psi$ — Axial compressive stress, TER Equation 2

$f_a = 940\ psi$ < $F_{cE} = 1091\ psi$ and < $F_c' = 940\ psi$ **OK**

$CSI := \frac{f_a}{F_c'} = 1.000$

Check Deflection Limit for BareNaked Tstud™:

$$\Delta := \frac{5 \cdot \left(0.7\ w\right) \cdot h^4}{384 \cdot EI} = 0.249\ in$$

$\frac{h}{\Delta} = 467$ > 240 **OK**

Summary of Design Calculations for BareNaked Tstud™:

The BareNaked Tstud™ has a calculated axial load capacity of 2465 lbs for an 10' tall wall with a 140 mph wind load. The axial load is limited by the compression strength of the BareNaked Tstud™ member under combined axial and wind loading.