DrJ™ CERTIFICATION

ANAB ANSI National Accreditation Board ACCREDITED ISO/IEC 17065 PRODUCT CERTIFICATION BODY

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Technical Evaluation Report

TER 1904-03

Tstud™ – Canada – Limit States Design

US Engineered Wood, Inc.

Product:

Tstud™ Structural Insulated Wall Stud

Issue Date:

July 8, 2019

Revision Date:

September 26, 2022

Subject to Renewal:

October 1, 2023

COMPANY INFORMATION:

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DIVISION: 06 00 00 - WOOD, PLASTICS AND COMPOSITES

SECTION: 06 10 00 - Rough Carpentry

DIVISION: 07 00 00 - THERMAL AND MOISTURE PROTECTION

SECTION: 07 21 00 - Building Insulation

SECTION: 07 21 13 - Foam Board Insulation

1 Product Evaluated[1]

1.1 Tstud™ Structural Insulated Wall Stud

2 Applicable Codes and Standards[2,3]

2.1 *Codes*

2.1.1 *NBC—10, 15, 20: National Building Code of Canada*

2.1.2 *NECB—17, 20: National Energy Code of Canada for Buildings*

2.1.3 *O Reg. 332/12 – Ontario Building Code (OBC)*[4]

2.2 *Standards and Referenced Documents*

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

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

2.2.3 *ASTM D2915: Sampling and Data Analysis for Structural Wood and Wood Based Products*

2.2.4 *ASTM E2126: Standard Test Methods for Cyclic (Reversed) Load Test for Shear Resistance of Vertical Elements of the Lateral Force Resisting Systems for Buildings*

2.2.5 *ASTM E72: Standard Test Methods of Conducting Strength Tests of Panels for Building Construction*

2.2.6 *CSA O86: Engineering Design in Wood*

[1] For more information, visit drjcertification.org or call us at 608-310-6748.

[2] Unless otherwise noted, all references in this TER are from the 2020 version of the *NBC*. This *alternative solution* is also approved for use with the 2010 and 2015 *NBC* and the standards referenced therein.

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

[4] References in this TER to the National Building Code of Canada (*NBC)* apply to the Ontario Building Code (*OBC*), unless noted otherwise.

3 Performance Evaluation

3.1 Tstud™ was evaluated to determine its applicability for use as an alternative material where nominal 2″x4″ (38x89 mm) and 2″x6″ (38x140 mm) solid sawn lumber is specified in accordance with the *NBC* including use as wall studs, top and bottom wall plates, and headers.

3.2 Tstud™ testing and analysis was conducted to determine its compression, flexural strengths, and flexural stiffness.

3.3 This TER evaluates Tstud™ for the following:

3.3.1 Use as an alternative solution to that described in *NBC* Division B Part 4, in particular, compliance with requirements for the design and construction of wood-based products as described in *NBC* Subsection 4.1.3 for limit states design (LSD).

3.3.2 Structural performance under lateral load conditions for use with the *CSA O86* performance-based provisions, *CSA O86* Section 11.3 and Subsection 11.6.2,[5] for light-frame shear walls.

3.3.2.1 Table 12 provides seismic design coefficients (SDC) that conform to the requirements in *NBC* Division B Subsection 4.1.8 for design of wall assemblies in buildings that require seismic design in accordance with NBC.

3.3.2.2 The basis for equivalency testing is outlined in Sentence 4.1.8.9.(5) of *NBC*:

> If it can be demonstrated through testing, research and analysis that the seismic performance of a structural system is at least equivalent to one of the types of SFRS mentioned in Table 4.1.8.9., then such structural system will qualify for values of R_d and R_o corresponding to the equivalent type in that Table. (See Note A-4.1.8.9.(5).

3.3.3 Compliance with *NBC* Section 4.1, *CSA O86* per *NBC* Subsection 4.3.1, and *NBC* Section 9.23 for wood frame construction applications.

3.3.4 Use as an alternative material and method of construction in compliance with *NBC* Article 1.2.1.1.

3.3.4.1 When used in an application that exceeds the limits of *NBC* Section 4.1 or *NBC* Section 9.23, an engineered design shall be submitted in accordance with *NBC* Volume 1 commentary on Conformity Assessment and this TER.

3.4 Evaluation of Tstud™ for performance under seismic loading 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.

3.7 Douglas Consultants Inc. has collaborated with DrJ through the review of this technical evaluation.

5 2014 *CSA O86* Subsection 11.5.1

4 Product Description and Materials

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

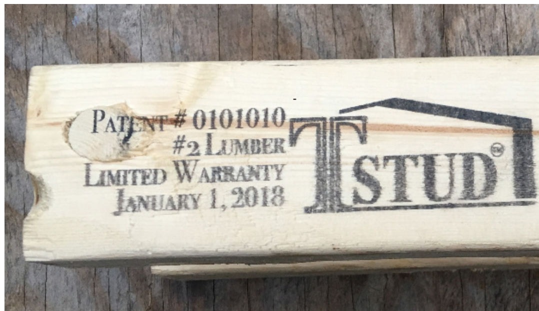

Figure 1. Tstud™ Product Stamp

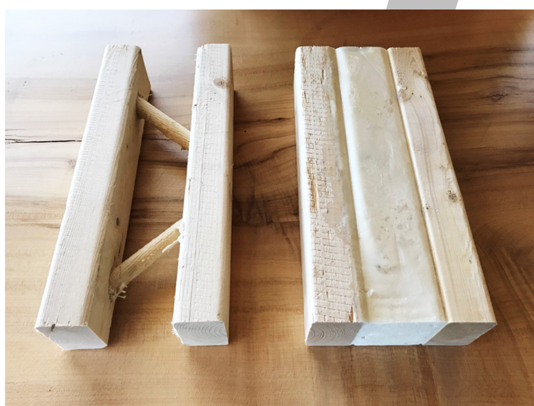

Figure 2. Tstud™ Without Polyiso (left) and Final Product (right)

4.2 Tstud™ is made from a minimum of 2" x 3" (38 x 64 mm) No. 2 Spruce Pine Fir (SPF) lumber, wooden dowels, and approximately 64 mm (2½") of polyisocyanurate (polyiso) insulation.

4.2.1 Overall size of Tstud™ is 64 mm x 140 mm (2½" x 5½").

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

4.2.3 The lumber is placed in a form that leaves a gap of approximately 64 mm (2½") between members. Wooden dowels are installed through one member into the other at opposing angles, forming a web-like pattern. Dowels are spaced evenly at a distance not exceeding 165 mm (6½") on center and glued in place using an adhesive that conforms to the specifications of *ASTM D2559*.

4.2.4 Once the lumber has been fastened together, liquid polyiso is poured into the void between members and given time to harden.

4.3 *Materials*

4.3.1 *Lumber:*

4.3.1.1 Grade: No. 2 SPF or 1650f – 1.5E SPF

4.3.1.2 Thickness: 38 mm (1½")

4.3.1.3 Width: 64 mm (2½")

4.3.1.4 Length: up to 4.9 m (16')

4.3.2 *Dowels:*

4.3.2.1 Grade: No. 2 SPF or 1650f – 1.5E SPF

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

4.3.3 *Polyiso:*

4.3.3.1 The polyiso is manufactured with a minimum density of 345.6 N/m^3 (2.2 lb/ft^3).

5 Applications

5.1 *Prescriptive Provisions*

5.1.1 Tstud™ is an alternative to solid sawn 2" x 4" lumber in all cases and 2" x 6" lumber in most cases for wall structural members.

5.1.1.1 For use as a 2" x 6", 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 *NBC* Section 4.1 and *CSA O86* per *NBC* Subsection 4.3.1.

5.1.2 Polyiso insulation is in accordance with *NBC* Division B Article 3.1.5.15 and *OBC* Article 3.1.5.12.

5.1.3 *Cutting, notching, and boring:*

5.1.3.1 Notches in structural members (2" x 3" or dowels) are not permitted.

5.1.3.2 Holes may only be bored in polyiso insulation of Tstud™. Holes shall be spaced a minimum of 610 mm (24") o.c., shall not exceed 64 mm (2½") in diameter, and are not permitted within 610 mm (24") from either end of the stud.

5.1.3.3 Tstud™ used as structural members of a wall shall be fastened as specified in Table 1.

Table 1. Acceptable Uses of Tstud™

Application[1]	Number & Type of Fastener	Fastener Spacing, mm (in)	Installation
Ceiling Joists to Plate (toe nail)	(3) - 4" × 0.131" (3.3 mm)	–	Fasten two (2) toe nails into interior wood member and one (1) toe nail into exterior wood member
Rim Joist to Sill or Top Plate	2½" × 0.113" (2.9 mm)	102 (4) o.c.	Fasten by toe-nailing
	2½" × 0.131" (3.3 mm)	152 (6) o.c.	
Rafter or Roof Truss to Plate (toe nail)	(3) - 3½" × 0.135" (3.4 mm)	–	Fasten two (2) toe nails into interior wood member and two (2) toe nails into exterior wood member
	(4) – 4" × 0.131" (3.3 mm)		Where a rafter is fastened to an adjacent parallel ceiling joist in accordance with this schedule, provide two (2) toe nails on one (1) side of the rafter and toe nails from the ceiling joist to top plate in accordance with this schedule. The toe nail on the opposite side of the rafter shall not be required.
Built-up Studs (face nail)	4" × 0.131" (3.3 mm)	406 (16) o.c.	Fasten two (2) face nails, one (1) into each wood member
Abutting Studs at Intersecting Wall Corners (face nail)	4" × 0.131" (3.3 mm)	305 (12) o.c.	Fasten one (1) face nail into exterior-facing wood member
Double 2"x6" Top Plates (face nail)	4" × 0.131" (3.3 mm)	305 (12) o.c.	Fasten two (2) face nails, one (1) into each wood member
Double Top Plates, Minimum 24" Offset of End Joints, Face Nail in Lapped Area	(12) – 4" × 0.131" (3.3 mm)	–	Fasten twelve (12) face nails on each side of end joint (minimum 610 mm (24") lap splice length each side of joint)
Stud to Plate (toe nail)	(4) – 4" × 0.131" (3.3 mm)	–	Fasten two (2) toe nails into sole plate on each side of the stud (each wood member)
Plate to Stud (end nail)	(3) – 4" × 0.131" (3.3 mm)	–	Fasten two (2) 4" x 0.131" nails into one wood member and one (1) 4" x 0.131" nail into other wood member
	(2) – 4½" × 0.162" (4.1 mm)		Fasten two (2) 4½" x 0.162" nails, one (1) into each wood member
Top Plates, Laps at Corners & Intersections (face nail)	(2) – 4" × 0.131" (3.3 mm)	–	Fasten two (2) 4" x 0.131" face nails, one into each wood member

SI: 1 mm = 0.0394 in

1. For all connections, care shall be taken to avoid splitting.

5.1.4 Tstud™ may be used as a single top plate in accordance with *NBC* Division B Article 9.23.11.3 and the following:

5.1.4.1 Fasteners for Tstud™ connections shall be distributed in each Tstud™ wood member. Top plate to stud connections shall be fastened using three (3) 4" x 0.131" (3.3 mm) nails: one (1) into one wood member and two (2) into the other wood member.

5.1.5 Tstud™ may be used as a flat header.

5.1.5.1 Fasten multi-ply Tstud™ header members using 4" x 0.131" (3.3 mm) nails. Drive one nail into each Tstud™ wood member at 406 mm (16") o.c. i.e. In other words, 406 mm (16") o.c. along each side of the Tstud™.

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

5.1.6.1 Install cripple studs between the bottom plate and rough sill using three (3) 4" x 0.131" (3.3 mm) nails: one (1) into one wood member and two (2) into the other wood member.

5.1.7 Structural sheathing shall be installed on one side of the wall, and a minimum 12.7 mm (½") gypsum wallboard (GWB), or equivalent, shall be installed on the other side fastened in accordance with the applicable building code. Sheathing attached to only one side of the wall is not permitted.

5.1.8 For trusses and rafters placed on Tstud™ walls, see Table 3 for SPF No. 2 Tstud™ and Table 4 for 1650Fb-1.5E MSR Tstud™ design values.

5.1.8.1 For cases where a higher reaction needs to be supported, use of built-up studs fastened in accordance with Table 1 is permitted with a compression limit per-ply specified in Table 3 and Table 4.

5.1.8.1.1 For example, for SPF No. 2 Tstud™ and SPF top plate, the maximum compression load is 23.1 kN (5,193 lbs) per ply. Therefore, for a 2-ply built-up stud, the maximum reaction is 46.2 kN (10,386 lbs).

5.1.8.1.2 In this case, the built-up stud shall be located directly under the applied load.

5.1.9 Walls with nominal 2x6 lumber top plates shall be in accordance with *NBC* Division B Article 9.23.11.3.

5.2 *Engineering Design*

5.2.1 The design provisions for wood construction noted in *NBC* Division B Subsection 4.1.3 apply to Tstud™ for LSD, unless otherwise noted in this TER.

5.2.2 *Material Properties:*

5.2.2.1 Specified design values for Tstud™ are defined in Table 2.

Table 2. Tstud™ Specified Design Values for LSD

Specified Design Values	No. 2 SPF Tstud™	1650f – 1.5E SPF Tstud™
Specified Bending, f_bS	2,215 N-m (1,635 lb-ft)	2,215 N-m (1,635 lb-ft)
Specified Compression Parallel to Grain, f_c	11.5 MPa (1 665 psi)	18.1 MPa (2 620 psi)
Specified Tension Parallel to Grain, f_t	5.5 MPa (795 psi)	11.4 MPa (1 650 psi)
Specified Compression Perpendicular to Grain, f_{cp}	5.3 MPa (765 psi)	5.3 MPa (765 psi)
Specified Shear Force, V_c	2.63 kN (590 lb)	2.63 kN (590 lb)
Bending Stiffness, EI	86,900 N-m^2 (30,200,000 lb-in^2)	87,600 N-m^2 (30,500,000 lb-in^2)
Bending Stiffness for Beam and Column Stability, EI_{05}	75,600 N-m^2 (26,300,000 lb-in^2)	76,200 N-m^2 (26,500,000 lb-in^2)
SI: 1 mm = 0.0394 in, 1 N = 0.225 lb, 1 kN/m = 68.5 lb/ft, 1 kN/m^2 = 20.9 psf, 1 MPa = 145 psi		

5.2.2.2 Reference design values for Tstud™ shall be multiplied by the adjustment factors defined in *CSA O86* Section 15.3.2 and Section 6.4.

5.2.3 *Design for Axial Loads:*

5.2.3.1 The maximum factored compressive load for Tstud™ is defined in Table 3 for SPF No. 2 Tstud™ and Table 4 for 1650Fb-1.5E MSR Tstud™.

5.2.3.2 The maximum factored compressive load is based on the minimum of perpendicular-to-grain crushing of SPF, LVL, or LSL top and bottom plates, and compression parallel to grain of the Tstud™.

5.2.3.3 The factored compressive resistance parallel to grain for Tstud™ can be calculated using the provisions of *CSA O86* Subsection 15.3.3.4.

5.2.3.4 The factored compressive resistance parallel to grain, P_r, shall be computed using the formula:

$$P_r = \varphi F_c A K_C K_{Zc}$$

Where: A = net cross-sectional area of Tstud™

= 38 mm x (2 x 63.5 mm – 17.5 mm) = 4 161 mm^2

5.2.3.5 For computing stability, the Euler buckling load in the plane of the applied moment, P_E, shall be computed using the formula:

$$P_E = \frac{\pi E_{05} K_{SE} K_T I}{L_E^2}$$

Table 3. Maximum Factored Compressive Load for SPF No. 2 Tstud™ [1]

Tstud™ Length m (ft)	Factored Compressive Load kN (lbs)		
	Top/Bottom Plate[2]		
	Tstud™ (SPF)[3] (SG = 0.42)	LVL[4]	LSL[5]
2.44 (8)	23.1 (5193)	24.9 (5598)	24.0 (5396)
2.74 (9)	23.1 (5193)	24.9 (5598)	24.0 (5396)
3.05 (10)	23.1 (5193)	24.9 (5598)	24.0 (5396)
3.35 (11)	23.1 (5193)	24.9 (5598)	24.0 (5396)
3.66 (12)	23.1 (5193)	23.3 (5238)	23.3 (5238)
3.96 (13)	21.0 (4721)	21.0 (4721)	21.0 (4721)
4.27 (14)	18.8 (4227)	18.8 (4227)	18.8 (4227)
4.57 (15)	16.8 (3777)	16.8 (3777)	16.8 (3777)
4.88 (16)	15.0 (3372)	15.0 (3372)	15.0 (3372)

SI: 1" = 25.4 mm, 1 lb = 4.448 N

1. Maximum stud spacing of 24".
2. Specified compression perpendicular to grain strength is assumed to be 5.3 MPa for SPF (per CSA O86 Table 6.3.1A), 5.7 MPa for LVL, and 5.5 MPa for LSL. Adjustment for plates having a higher or lower value for compression perpendicular to grain is required.
3. Compression perpendicular to grain of the SPF top and bottom plates controls for walls less than or equal to 12 ft. in height.
4. Compression perpendicular to grain of the LVL top and bottom plates controls for walls less than or equal to 11 ft. in height.
5. Compression perpendicular to grain of the LSL top and bottom plates controls for walls less than or equal to 11 ft. in height.

Table 4. Maximum Factored Compressive Load for 1650Fb-1.5E MSR Tstud™ [1]

Tstud™ Length m (ft)	Factored Compressive Load kN (lbs)		
	Top/Bottom Plate[2]		
	Tstud™ (SPF)[3] (SG = 0.42)	LVL[4]	LSL[5]
2.44 (8)	23.1 (5193)	24.9 (5598)	24.0 (5396)
2.74 (9)	23.1 (5193)	24.9 (5598)	24.0 (5396)
3.05 (10)	23.1 (5193)	24.9 (5598)	24.0 (5396)
3.35 (11)	23.1 (5193)	24.9 (5598)	24.0 (5396)
3.66 (12)	23.1 (5193)	24.9 (5598)	24.0 (5396)
3.96 (13)	23.1 (5193)	24.9 (5598)	24.0 (5396)
4.27 (14)	23.1 (5193)	23.9 (5373)	23.9 (5373)
4.57 (15)	21.0 (4721)	21.0 (4721)	21.0 (4721)
4.88 (16)	18.3 (4114)	18.3 (4114)	18.3 (4114)

SI: 1" = 25.4 mm, 1 lb = 4.448 N

1. Maximum stud spacing of 24".
2. Specified compression perpendicular to grain strength is assumed to be 5.3 MPa for SPF (per CSA O86 Table 6.3.1A), 5.7 MPa for LVL, and 5.5 MPa for LSL. Adjustment for plates having a higher or lower value for compression perpendicular to grain is required.
3. Compression perpendicular to grain of the SPF top and bottom plates controls for walls less than or equal to 14 ft. in height.
4. Compression perpendicular to grain of the LVL top and bottom plates controls for walls less than or equal to 13 ft. in height.
5. Compression perpendicular to grain of the LSL top and bottom plates controls for walls less than or equal to 13 ft. in height.

5.2.4 *Design for Bending:*

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

5.2.5 *Design for Combined Bending and Axial Compression Loads:*

5.2.5.1 The Tstud™ resists bending using tension and compression stresses in the wood members.

5.2.5.2 The resistance to combined bending and axial loads can be computed using the following equation:

$$\left(\frac{P_f}{P_r}\right)^2 + \frac{M_f}{M_r}\left[\frac{1}{1-\frac{P_f}{P_E}}\right] \leq 1$$

Where: P_f = factored compressive axial load applied to Tstud™ (N)

P_r = factored compressive resistance parallel to grain of Tstud™ (N)

M_f = factored bending moment applied to Tstud™ (N-m)

M_r = factored bending moment resistance of Tstud™ (N-m)

P_E = Euler buckling load (N)

5.2.5.3 The axial loads in Tstud™ member shall be checked in accordance with *CSA O86* Subsection 15.3.3.4 and 15.3.3.6.

5.2.5.4 The equation in Section 5.2.5.2 includes a check to ensure the factored bending moment in Table 2 is not exceeded for Tstud™.

5.2.5.5 Specified wind pressure resistances for Tstud™ subject to axial loads are provided in the following tables:

5.2.5.5.1 SPF No. 2 Tstud™

5.2.5.5.1.1 SPF top/bottom plate: Table 5

5.2.5.5.1.2 LVL top/bottom plate: Table 6

5.2.5.5.1.3 LSL top/bottom plate: Table 7

5.2.5.5.2 1650Fb-1.5E MSR Tstud™

5.2.5.5.2.1 SPF top/bottom plate: Table 8

5.2.5.5.2.2 LVL top/bottom plate: Table 9

5.2.5.5.2.3 LSL top/bottom plate: Table 10

Table 5. LSD Factored Axial Load for Walls Subject to Wind Pressures
(SPF No. 2 Tstud™ and SPF Top/Bottom Plate)

Stud Spacing mm (in)	Wall Height m (ft)	Factored Axial Load (kN) & (Deflection Ratio)									
		Specified Wind Pressure[1], p (kPa)									
		0.30	0.58	0.86	1.13	1.41	1.69	1.97	2.24	2.52	2.80
300 (12)	2.44 (8)	23.1 (L/7595)	23.1 (L/3944)	23.1 (L/2663)	23.1 (L/2011)	23.1 (L/1615)	23.1 (L/1349)	23.1 (L/1159)	23.1 (L/1015)	23.1 (L/903)	23.1 (L/814)
	2.74 (9)	23.1 (L/5260)	23.1 (L/2731)	23.1 (L/1845)	23.1 (L/1392)	23.1 (L/1118)	23.1 (L/934)	23.1 (L/802)	22.1 (L/703)	21.1 (L/626)	20 (L/564)
	3.05 (10)	23.1 (L/3792)	23.1 (L/1969)	23.1 (L/1330)	22.9 (L/1004)	21.6 (L/806)	20.3 (L/674)	19.1 (L/578)	17.8 (L/507)	16.5 (L/451)	15.3 (L/406)
	3.66 (12)	21.3 (L/2158)	19.5 (L/1121)	17.6 (L/757)	15.8 (L/571)	13.9 (L/459)	12.1 (L/383)	10.2 (L/329)	8.4 (L/289)	6.5 (L/257)	4.7 (L/231)
	4.27 (14)	16.1 (L/1343)	13.6 (L/697)	11 (L/471)	8.5 (L/356)	6.0 (L/286)	3.4 (L/239)	0.9 (L/205)	--	--	--
	4.88 (16)	11.4 (L/892)	8.0 (L/463)	4.7 (L/313)	1.4 (L/236)	--	--	--	--	--	--
400 (16)	2.44 (8)	23.1 (L/5697)	23.1 (L/2958)	23.1 (L/1997)	23.1 (L/1508)	23.1 (L/1211)	23.1 (L/1012)	23.1 (L/869)	23.1 (L/761)	22.7 (L/678)	21.7 (L/610)
	2.74 (9)	23.1 (L/3945)	23.1 (L/2049)	23.1 (L/1383)	23.1 (L/1044)	23.1 (L/839)	22.1 (L/701)	20.7 (L/602)	19.3 (L/527)	18 (L/469)	16.6 (L/423)
	3.05 (10)	23.1 (L/2844)	23.1 (L/1477)	22.8 (L/997)	21.1 (L/753)	19.5 (L/605)	17.8 (L/505)	16.1 (L/434)	14.4 (L/380)	12.7 (L/338)	11 (L/305)
	3.66 (12)	20.7 (L/1619)	18.2 (L/841)	15.7 (L/568)	13.3 (L/429)	10.8 (L/344)	8.3 (L/288)	5.9 (L/247)	3.4 (L/216)	0.9 (L/193)	--
	4.27 (14)	15.2 (L/1007)	11.8 (L/523)	8.4 (L/353)	5.0 (L/267)	1.7 (L/214)	--	--	--	--	--
	4.88 (16)	10.2 (L/669)	5.7 (L/347)	1.3 (L/235)	--	--	--	--	--	--	--
600 (24)	2.44 (8)	23.1 (L/3798)	23.1 (L/1972)	23.1 (L/1332)	23.1 (L/1005)	23.1 (L/807)	22.7 (L/675)	21.1 (L/579)	19.5 (L/508)	17.9 (L/452)	16.3 (L/407)
	2.74 (9)	23.1 (L/2630)	23.1 (L/1366)	23.1 (L/922)	22.0 (L/696)	20.0 (L/559)	17.9 (L/467)	15.9 (L/401)	13.8 (L/352)	11.8 (L/313)	9.8 (L/282)
	3.05 (10)	23.1 (L/1896)	22.8 (L/985)	20.2 (L/665)	17.7 (L/502)	15.2 (L/403)	12.6 (L/337)	10.1 (L/289)	7.5 (L/253)	5.0 (L/226)	2.5 (L/203)
	3.66 (12)	19.3 (L/1079)	15.6 (L/560)	11.9 (L/378)	8.2 (L/286)	4.5 (L/229)	0.8 (L/192)	--	--	--	--
	4.27 (14)	13.4 (L/672)	8.3 (L/349)	3.2 (L/236)	--	--	--	--	--	--	--
	4.88 (16)	7.8 (L/446)	1.1 (L/232)	--	--	--	--	--	--	--	--

SI: 25.4 mm = 1 in, 1 N = 0.225 lb, 1 MPa = 145 psi

1. The specified wind pressures provided above are for ultimate limit states (ULS), which uses an importance factor of 1, and are used to determine the allowable axial load in accordance with NBC Division B Article 4.1.7.3. The deflection ratio is based on serviceability limit states (SLS) per NBC Article 4.1.3.5, which uses an importance factor of 0.75 when determining specified wind pressure.

Table 6. LSD Factored Axial Load for Walls Subject to Wind Pressures
(SPF No. 2 Tstud™ and LVL[2] Top/Bottom Plate)

Stud Spacing mm (in)	Wall Height m (ft)	Factored Axial Load (kN) & (Deflection Ratio)									
		Specified Wind Pressure[1], p (kPa)									
		0.30	0.58	0.86	1.13	1.41	1.69	1.97	2.24	2.52	2.80
300 (12)	2.44 (8)	24.9 (L/7595)	24.9 (L/3944)	24.9 (L/2663)	24.9 (L/2011)	24.9 (L/1615)	24.9 (L/1349)	24.9 (L/1159)	24.9 (L/1015)	24.9 (L/903)	24.4 (L/814)
	2.74 (9)	24.9 (L/5260)	24.9 (L/2731)	24.9 (L/1845)	24.9 (L/1392)	24.9 (L/1118)	24.1 (L/934)	23.1 (L/802)	22.1 (L/703)	21.1 (L/626)	20 (L/564)
	3.05 (10)	24.9 (L/3792)	24.9 (L/1969)	24.1 (L/1330)	22.9 (L/1004)	21.6 (L/806)	20.3 (L/674)	19.1 (L/578)	17.8 (L/507)	16.5 (L/451)	15.3 (L/406)
	3.66 (12)	21.3 (L/2158)	19.5 (L/1121)	17.6 (L/757)	15.8 (L/571)	13.9 (L/459)	12.1 (L/383)	10.2 (L/329)	8.4 (L/289)	6.5 (L/257)	4.7 (L/231)
	4.27 (14)	16.1 (L/1343)	13.6 (L/697)	11.0 (L/471)	8.5 (L/356)	6.0 (L/286)	3.4 (L/239)	0.9 (L/205)	--	--	--
	4.88 (16)	11.4 (L/892)	8.0 (L/463)	4.7 (L/313)	1.4 (L/236)	--	--	--	--	--	--
400 (16)	2.44 (8)	24.9 (L/5697)	24.9 (L/2958)	24.9 (L/1997)	24.9 (L/1508)	24.9 (L/1211)	24.9 (L/1012)	24.9 (L/869)	23.8 (L/761)	22.7 (L/678)	21.7 (L/610)
	2.74 (9)	24.9 (L/3945)	24.9 (L/2049)	24.9 (L/1383)	24.8 (L/1044)	23.4 (L/839)	22.1 (L/701)	20.7 (L/602)	19.3 (L/527)	18.0 (L/469)	16.6 (L/423)
	3.05 (10)	24.9 (L/2844)	24.5 (L/1477)	22.8 (L/997)	21.1 (L/753)	19.5 (L/605)	17.8 (L/505)	16.1 (L/434)	14.4 (L/380)	12.7 (L/338)	11.0 (L/305)
	3.66 (12)	20.7 (L/1619)	18.2 (L/841)	15.7 (L/568)	13.3 (L/429)	10.8 (L/344)	8.3 (L/288)	5.9 (L/247)	3.4 (L/216)	0.9 (L/193)	--
	4.27 (14)	15.2 (L/1007)	11.8 (L/523)	8.4 (L/353)	5.0 (L/267)	1.7 (L/214)	--	--	--	--	--
	4.88 (16)	10.2 (L/669)	5.7 (L/347)	1.3 (L/235)	--	--	--	--	--	--	--
600 (24)	2.44 (8)	24.9 (L/3798)	24.9 (L/1972)	24.9 (L/1332)	24.9 (L/1005)	24.3 (L/807)	22.7 (L/675)	21.1 (L/579)	19.5 (L/508)	17.9 (L/452)	16.3 (L/407)
	2.74 (9)	24.9 (L/2630)	24.9 (L/1366)	24.0 (L/922)	22.0 (L/696)	20.0 (L/559)	17.9 (L/467)	15.9 (L/401)	13.8 (L/352)	11.8 (L/313)	9.8 (L/282)
	3.05 (10)	24.9 (L/1896)	22.8 (L/985)	20.2 (L/665)	17.7 (L/502)	15.2 (L/403)	12.6 (L/337)	10.1 (L/289)	7.5 (L/253)	5.0 (L/226)	2.5 (L/203)
	3.66 (12)	19.3 (L/1079)	15.6 (L/560)	11.9 (L/378)	8.2 (L/286)	4.5 (L/229)	0.8 (L/192)	--	--	--	--
	4.27 (14)	13.4 (L/672)	8.3 (L/349)	3.2 (L/236)	--	--	--	--	--	--	--
	4.88 (16)	7.8 (L/446)	1.1 (L/232)	--	--	--	--	--	--	--	--

Stud Spacing mm (in)	Wall Height m (ft)	Factored Axial Load (kN) & (Deflection Ratio)									
		Specified Wind Pressure[1], p (kPa)									
		0.30	0.58	0.86	1.13	1.41	1.69	1.97	2.24	2.52	2.80

SI: 25.4 mm = 1 in, 1 N = 0.225 lb, 1 MPa = 145 psi

1. The specified wind pressures provided above are for ultimate limit states (ULS), which uses an importance factor of 1, and are used to determine the allowable axial load in accordance with NBC Division B Article 4.1.7.3. The deflection ratio is based on serviceability limit states (SLS) per NBC Article 4.1.3.5, which uses an importance factor of 0.75 when determining specified wind pressure.
2. LVL assumed to have a compression perpendicular to grain strength of 5.7 MPa.

Table 7. LSD Factored Axial Load for Walls Subject to Wind Pressures
(SPF No. 2 Tstud™ and LSL[2] Top/Bottom Plate)

Stud Spacing mm (in)	Wall Height m (ft)	Factored Axial Load (kN) & (Deflection Ratio)									
		Specified Wind Pressure[1], p (kPa)									
		0.30	0.58	0.86	1.13	1.41	1.69	1.97	2.24	2.52	2.80
300 (12)	2.44 (8)	24.0 (L/7595)	24.0 (L/3944)	24.0 (L/2663)	24.0 (L/2011)	24.0 (L/1615)	24.0 (L/1349)	24.0 (L/1159)	24.0 (L/1015)	24.0 (L/903)	24.0 (L/814)
	2.74 (9)	24.0 (L/5260)	24.0 (L/2731)	24.0 (L/1845)	24.0 (L/1392)	24.0 (L/1118)	24.0 (L/934)	23.1 (L/802)	22.1 (L/703)	21.1 (L/626)	20.0 (L/564)
	3.05 (10)	24.0 (L/3792)	24.0 (L/1969)	24.0 (L/1330)	22.9 (L/1004)	21.6 (L/806)	20.3 (L/674)	19.1 (L/578)	17.8 (L/507)	16.5 (L/451)	15.3 (L/406)
	3.66 (12)	21.3 (L/2158)	19.5 (L/1121)	17.6 (L/757)	15.8 (L/571)	13.9 (L/459)	12.1 (L/383)	10.2 (L/329)	8.4 (L/289)	6.5 (L/257)	4.7 (L/231)
	4.27 (14)	16.1 (L/1343)	13.6 (L/697)	11.0 (L/471)	8.5 (L/356)	6.0 (L/286)	3.4 (L/239)	0.9 (L/205)	--	--	--
	4.88 (16)	11.4 (L/892)	8.0 (L/463)	4.7 (L/313)	1.4 (L/236)	--	--	--	--	--	--
400 (16)	2.44 (8)	24.0 (L/5697)	24.0 (L/2958)	24.0 (L/1997)	24.0 (L/1508)	24.0 (L/1211)	24.0 (L/1012)	24.0 (L/869)	23.8 (L/761)	22.7 (L/678)	21.7 (L/610)
	2.74 (9)	24.0 (L/3945)	24.0 (L/2049)	24.0 (L/1383)	24.0 (L/1044)	23.4 (L/839)	22.1 (L/701)	20.7 (L/602)	19.3 (L/527)	18.0 (L/469)	16.6 (L/423)
	3.05 (10)	24.0 (L/2844)	24.0 (L/1477)	22.8 (L/997)	21.1 (L/753)	19.5 (L/605)	17.8 (L/505)	16.1 (L/434)	14.4 (L/380)	12.7 (L/338)	11.0 (L/305)
	3.66 (12)	20.7 (L/1619)	18.2 (L/841)	15.7 (L/568)	13.3 (L/429)	10.8 (L/344)	8.3 (L/288)	5.9 (L/247)	3.4 (L/216)	0.9 (L/193)	--
	4.27 (14)	15.2 (L/1007)	11.8 (L/523)	8.4 (L/353)	5.0 (L/267)	1.7 (L/214)	--	--	--	--	--
	4.88 (16)	10.2 (L/669)	5.7 (L/347)	1.3 (L/235)	--	--	--	--	--	--	--
600 (24)	2.44 (8)	24.0 (L/3798)	24.0 (L/1972)	24.0 (L/1332)	24.0 (L/1005)	24.0 (L/807)	22.7 (L/675)	21.1 (L/579)	19.5 (L/508)	17.9 (L/452)	16.3 (L/407)
	2.74 (9)	24.0 (L/2630)	24.0 (L/1366)	24.0 (L/922)	22.0 (L/696)	20.0 (L/559)	17.9 (L/467)	15.9 (L/401)	13.8 (L/352)	11.8 (L/313)	9.8 (L/282)
	3.05 (10)	24.0 (L/1896)	22.8 (L/985)	20.2 (L/665)	17.7 (L/502)	15.2 (L/403)	12.6 (L/337)	10.1 (L/289)	7.5 (L/253)	5.0 (L/226)	2.5 (L/203)

Stud Spacing mm (in)	Wall Height m (ft)	Factored Axial Load (kN) & (Deflection Ratio)									
		Specified Wind Pressure[1], p (kPa)									
		0.30	0.58	0.86	1.13	1.41	1.69	1.97	2.24	2.52	2.80
	3.66 (12)	19.3 (L/1079)	15.6 (L/560)	11.9 (L/378)	8.2 (L/286)	4.5 (L/229)	0.8 (L/192)	--	--	--	--
	4.27 (14)	13.4 (L/672)	8.3 (L/349)	3.2 (L/236)	--	--	--	--	--	--	--
	4.88 (16)	7.8 (L/446)	1.1 (L/232)	--	--	--	--	--	--	--	--

SI: 25.4 mm = 1 in, 1 N = 0.225 lb, 1 MPa = 145 psi

1. The specified wind pressures provided above are for ultimate limit states (ULS), which uses an importance factor of 1, and are used to determine the allowable axial load in accordance with NBC Division B Article 4.1.7.3. The deflection ratio is based on serviceability limit states (SLS) per NBC Article 4.1.3.5, which uses an importance factor of 0.75 when determining specified wind pressure.
2. LSL assumed to have a compression perpendicular to grain strength of 5.5 MPa.

Table 8. LSD Factored Axial Load for Walls Subject to Wind Pressures
(1650f – 1.5e Tstud™ and SPF Top/Bottom Plate)

Stud Spacing mm (in)	Wall Height m (ft)	Factored Axial Load (kN) & (Deflection Ratio)									
		Specified Wind Pressure[1], p (kPa)									
		0.30	0.58	0.86	1.13	1.41	1.69	1.97	2.24	2.52	2.80
300 (12)	2.44 (8)	23.1 (L/7655)	23.1 (L/3975)	23.1 (L/2680)	23.1 (L/2025)	23.1 (L/1625)	23.1 (L/1360)	23.1 (L/1165)	23.1 (L/1020)	23.1 (L/910)	23.1 (L/820)
	2.74 (9)	23.1 (L/5300)	23.1 (L/2750)	23.1 (L/1855)	23.1 (L/1400)	23.1 (L/1125)	23.1 (L/940)	23.1 (L/805)	23.1 (L/705)	23.1 (L/630)	23.1 (L/565)
	3.05 (10)	23.1 (L/3820)	23.1 (L/1980)	23.1 (L/1340)	23.1 (L/1010)	23.1 (L/810)	23.1 (L/675)	23.1 (L/580)	23.1 (L/510)	23.1 (L/450)	23.1 (L/405)
	3.66 (12)	23.1 (L/2175)	23.1 (L/1125)	23.1 (L/760)	23.1 (L/575)	21.6 (L/460)	19.8 (L/385)	17.9 (L/330)	16.1 (L/290)	14.2 (L/255)	12.4 (L/230)
	4.27 (14)	21.2 (L/1350)	18.7 (L/700)	16.1 (L/470)	13.6 (L/355)	11.1 (L/285)	8.5 (L/240)	6.0 (L/205)	3.5 (L/180)	0.9 (L/160)	--
	4.88 (16)	14.7 (L/895)	11.4 (L/465)	8.1 (L/315)	4.7 (L/235)	1.4 (L/190)	--	--	--	--	--
400 (16)	2.44 (8)	23.1 (L/5740)	23.1 (L/2980)	23.1 (L/2010)	23.1 (L/1520)	23.1 (L/1220)	23.1 (L/1020)	23.1 (L/875)	23.1 (L/765)	23.1 (L/680)	23.1 (L/615)
	2.74 (9)	23.1 (L/3975)	23.1 (L/2065)	23.1 (L/1390)	23.1 (L/1050)	23.1 (L/845)	23.1 (L/705)	23.1 (L/605)	23.1 (L/530)	23.1 (L/470)	23.1 (L/425)
	3.05 (10)	23.1 (L/2865)	23.1 (L/1485)	23.1 (L/1005)	23.1 (L/755)	23.1 (L/605)	23.1 (L/505)	23.1 (L/435)	23.1 (L/380)	23.1 (L/340)	22.2 (L/305)
	3.66 (12)	23.1 (L/1630)	23.1 (L/845)	23.1 (L/570)	21.0 (L/430)	18.5 (L/345)	16.0 (L/285)	13.6 (L/245)	11.1 (L/215)	8.6 (L/190)	6.2 (L/170)
	4.27 (14)	20.3 (L/1015)	16.9 (L/525)	13.5 (L/355)	10.2 (L/265)	6.8 (L/215)	3.4 (L/180)	--	--	--	--
	4.88 (16)	13.5 (L/670)	9.1 (L/350)	4.7 (L/235)	0.2 (L/175)	--	--	--	--	--	--
600	2.44 (8)	23.1 (L/3825)	23.1 (L/1985)	23.1 (L/1340)	23.1 (L/1010)	23.1 (L/810)	23.1 (L/680)	23.1 (L/580)	23.1 (L/510)	23.1 (L/455)	23.1 (L/410)

Stud Spacing mm (in)	Wall Height m (ft)	Factored Axial Load (kN) & (Deflection Ratio)									
		Specified Wind Pressure[1], p (kPa)									
		0.30	0.58	0.86	1.13	1.41	1.69	1.97	2.24	2.52	2.80
(24)	2.74 (9)	23.1 (L/2650)	23.1 (L/1375)	23.1 (L/925)	23.1 (L/700)	23.1 (L/560)	23.1 (L/470)	23.1 (L/400)	23.1 (L/350)	23.1 (L/315)	22.9 (L/280)
	3.05 (10)	23.1 (L/1910)	23.1 (L/990)	23.1 (L/670)	23.1 (L/505)	23.1 (L/405)	23.1 (L/335)	21.3 (L/290)	18.7 (L/255)	16.2 (L/225)	13.7 (L/200)
	3.66 (12)	23.1 (L/1085)	23.1 (L/560)	19.6 (L/380)	15.9 (L/285)	12.2 (L/230)	8.6 (L/190)	4.9 (L/165)	1.2 (L/145)	--	--
	4.27 (14)	18.5 (L/675)	13.4 (L/350)	8.3 (L/235)	3.3 (L/175)	--	--	--	--	--	--
	4.88 (16)	11.1 (L/445)	4.5 (L/230)	--	--	--	--	--	--	--	--

SI: 25.4 mm = 1 in, 1 N = 0.225 lb, 1 MPa = 145 psi

1. The specified wind pressures provided above are for ultimate limit states (ULS), which uses an importance factor of 1, and are used to determine the allowable axial load in accordance with NBC Division B Article 4.1.7.3. The deflection ratio is based on serviceability limit states (SLS) per NBC Article 4.1.3.5, which uses an importance factor of 0.75 when determining specified wind pressure.

Table 9. LSD Factored Axial Load for Walls Subject to Wind Pressures
(1650f – 1.5e Tstud™ and LVL[2] Top/Bottom Plate)

Stud Spacing mm (in)	Wall Height m (ft)	Factored Axial Load (kN) & (Deflection Ratio)									
		Specified Wind Pressure[1], p (kPa)									
		0.30	0.58	0.86	0.30	1.41	1.69	0.30	2.24	2.52	0.30
300 (12)	2.44 (8)	24.9 (L/7655)	24.9 (L/3975)	24.9 (L/2680)	24.9 (L/2025)	24.9 (L/1625)	24.9 (L/1360)	24.9 (L/1165)	24.9 (L/1020)	24.9 (L/910)	24.9 (L/820)
	2.74 (9)	24.9 (L/5300)	24.9 (L/2750)	24.9 (L/1855)	24.9 (L/1400)	24.9 (L/1125)	24.9 (L/940)	24.9 (L/805)	24.9 (L/705)	24.9 (L/630)	24.9 (L/565)
	3.05 (10)	24.9 (L/3820)	24.9 (L/1980)	24.9 (L/1340)	24.9 (L/1010)	24.9 (L/810)	24.9 (L/675)	24.9 (L/580)	24.9 (L/510)	24.9 (L/450)	24.9 (L/405)
	3.66 (12)	24.9 (L/2175)	24.9 (L/1125)	24.9 (L/760)	23.5 (L/575)	21.6 (L/460)	19.8 (L/385)	17.9 (L/330)	16.1 (L/290)	14.2 (L/255)	12.4 (L/230)
	4.27 (14)	21.2 (L/1350)	18.7 (L/700)	16.1 (L/470)	13.6 (L/355)	11.1 (L/285)	8.5 (L/240)	6.0 (L/205)	3.5 (L/180)	0.9 (L/160)	--
	4.88 (16)	14.7 (L/895)	11.4 (L/465)	8.1 (L/315)	4.7 (L/235)	1.4 (L/190)	--	--	--	--	--
400 (16)	2.44 (8)	24.9 (L/5740)	24.9 (L/2980)	24.9 (L/2010)	24.9 (L/1520)	24.9 (L/1220)	24.9 (L/1020)	24.9 (L/875)	24.9 (L/765)	24.9 (L/680)	24.9 (L/615)
	2.74 (9)	24.9 (L/3975)	24.9 (L/2065)	24.9 (L/1390)	24.9 (L/1050)	24.9 (L/845)	24.9 (L/705)	24.9 (L/605)	24.9 (L/530)	24.9 (L/470)	24.9 (L/425)
	3.05 (10)	24.9 (L/2865)	24.9 (L/1485)	24.9 (L/1005)	24.9 (L/755)	24.9 (L/605)	24.9 (L/505)	24.9 (L/435)	24.9 (L/380)	23.9 (L/340)	22.2 (L/305)
	3.66 (12)	24.9 (L/1630)	24.9 (L/845)	23.4 (L/570)	21 (L/430)	18.5 (L/345)	16.0 (L/285)	13.6 (L/245)	11.1 (L/215)	8.6 (L/190)	6.2 (L/170)
	4.27 (14)	20.3 (L/1015)	16.9 (L/525)	13.5 (L/355)	10.2 (L/265)	6.8 (L/215)	3.4 (L/180)	--	--	--	--

Stud Spacing mm (in)	Wall Height m (ft)	Factored Axial Load (kN) & (Deflection Ratio)									
		Specified Wind Pressure[1], p (kPa)									
		0.30	0.58	0.86	0.30	1.41	1.69	0.30	2.24	2.52	0.30
	4.88 (16)	13.5 (L/670)	9.1 (L/350)	4.7 (L/235)	0.2 (L/175)	--	--	--	--	--	--
600 (24)	2.44 (8)	24.9 (L/3825)	24.9 (L/1985)	24.9 (L/1340)	24.9 (L/1010)	24.9 (L/810)	24.9 (L/680)	24.9 (L/580)	24.9 (L/510)	24.9 (L/455)	24.9 (L/410)
	2.74 (9)	24.9 (L/2650)	24.9 (L/1375)	24.9 (L/925)	24.9 (L/700)	24.9 (L/560)	24.9 (L/470)	24.9 (L/400)	24.9 (L/350)	24.9 (L/315)	22.9 (L/280)
	3.05 (10)	24.9 (L/1910)	24.9 (L/990)	24.9 (L/670)	24.9 (L/505)	24.9 (L/405)	23.8 (L/335)	21.3 (L/290)	18.7 (L/255)	16.2 (L/225)	13.7 (L/200)
	3.66 (12)	24.9 (L/1085)	23.3 (L/560)	19.6 (L/380)	15.9 (L/285)	12.2 (L/230)	8.6 (L/190)	4.9 (L/165)	1.2 (L/145)	--	--
	4.27 (14)	18.5 (L/675)	13.4 (L/350)	8.3 (L/235)	3.3 (L/175)	--	--	--	--	--	--
	4.88 (16)	11.1 (L/445)	4.5 (L/230)	--	--	--	--	--	--	--	--

SI: 25.4 mm = 1 in, 1 N = 0.225 lb, 1 MPa = 145 psi

1. The specified wind pressures provided above are for ultimate limit states (ULS), which uses an importance factor of 1, and are used to determine the allowable axial load in accordance with NBC Division B Article 4.1.7.3. The deflection ratio is based on serviceability limit states (SLS) per NBC Article 4.1.3.5, which uses an importance factor of 0.75 when determining specified wind pressure.
2. LVL assumed to have a compression perpendicular to grain strength of 5.7 MPa.

Table 10. LSD Factored Axial Load for Walls Subject to Wind Pressures
(1650f – 1.5e Tstud™ and LSL[2] Top/Bottom Plate)

Stud Spacing mm (in)	Wall Height m (ft)	Factored Axial Load (kN) & (Deflection Ratio)									
		Specified Wind Pressure[1], p (kPa)									
		0.30	0.58	0.86	0.30	1.41	1.69	0.30	2.24	2.52	0.30
300 (12)	2.44 (8)	24.0 (L/7655)	24.0 (L/3975)	24.0 (L/2680)	24.0 (L/2025)	24.0 (L/1625)	24.0 (L/1360)	24.0 (L/1165)	24.0 (L/1020)	24.0 (L/910)	24.0 (L/820)
	2.74 (9)	24.0 (L/5300)	24.0 (L/2750)	24.0 (L/1855)	24.0 (L/1400)	24.0 (L/1125)	24.0 (L/940)	24.0 (L/805)	24.0 (L/705)	24.0 (L/630)	24.0 (L/565)
	3.05 (10)	24.0 (L/3820)	24.0 (L/1980)	24.0 (L/1340)	24.0 (L/1010)	24.0 (L/810)	24.0 (L/675)	24.0 (L/580)	24.0 (L/510)	24.0 (L/450)	24.0 (L/405)
	3.66 (12)	24.0 (L/2175)	24.0 (L/1125)	24.0 (L/760)	23.5 (L/575)	21.6 (L/460)	19.8 (L/385)	17.9 (L/330)	16.1 (L/290)	14.2 (L/255)	12.4 (L/230)
	4.27 (14)	21.2 (L/1350)	18.7 (L/700)	16.1 (L/470)	13.6 (L/355)	11.1 (L/285)	8.5 (L/240)	6.0 (L/205)	3.5 (L/180)	0.9 (L/160)	--
	4.88 (16)	14.7 (L/895)	11.4 (L/465)	8.1 (L/315)	4.7 (L/235)	1.4 (L/190)	--	--	--	--	--
400 (16)	2.44 (8)	24.0 (L/5740)	24.0 (L/2980)	24.0 (L/2010)	24.0 (L/1520)	24.0 (L/1220)	24.0 (L/1020)	24.0 (L/875)	24.0 (L/765)	24.0 (L/680)	24.0 (L/615)
	2.74 (9)	24.0 (L/3975)	24.0 (L/2065)	24.0 (L/1390)	24.0 (L/1050)	24.0 (L/845)	24.0 (L/705)	24.0 (L/605)	24.0 (L/530)	24.0 (L/470)	24.0 (L/425)

Stud Spacing mm (in)	Wall Height m (ft)	Factored Axial Load (kN) & (Deflection Ratio)									
		Specified Wind Pressure[1], p (kPa)									
		0.30	0.58	0.86	0.30	1.41	1.69	0.30	2.24	2.52	0.30
	3.05 (10)	24.0 (L/2865)	24.0 (L/1485)	24.0 (L/1005)	24.0 (L/755)	24.0 (L/605)	24.0 (L/505)	24.0 (L/435)	24.0 (L/380)	23.9 (L/340)	22.2 (L/305)
	3.66 (12)	24.0 (L/1630)	24.0 (L/845)	23.4 (L/570)	21.0 (L/430)	18.5 (L/345)	16.0 (L/285)	13.6 (L/245)	11.1 (L/215)	8.6 (L/190)	6.2 (L/170)
	4.27 (14)	20.3 (L/1015)	16.9 (L/525)	13.5 (L/355)	10.2 (L/265)	6.8 (L/215)	3.4 (L/180)	--	--	--	--
	4.88 (16)	13.5 (L/670)	9.1 (L/350)	4.7 (L/235)	0.2 (L/175)	--	--	--	--	--	--
600 (24)	2.44 (8)	24.0 (L/3825)	24.0 (L/1985)	24.0 (L/1340)	24.0 (L/1010)	24.0 (L/810)	24.0 (L/680)	24.0 (L/580)	24.0 (L/510)	24.0 (L/455)	24.0 (L/410)
	2.74 (9)	24.0 (L/2650)	24.0 (L/1375)	24.0 (L/925)	24.0 (L/700)	24.0 (L/560)	24.0 (L/470)	24.0 (L/400)	24.0 (L/350)	24.0 (L/315)	22.9 (L/280)
	3.05 (10)	24.0 (L/1910)	24.0 (L/990)	24.0 (L/670)	24.0 (L/505)	24.0 (L/405)	23.8 (L/335)	21.3 (L/290)	18.7 (L/255)	16.2 (L/225)	13.7 (L/200)
	3.66 (12)	24.0 (L/1085)	23.3 (L/560)	19.6 (L/380)	15.9 (L/285)	12.2 (L/230)	8.6 (L/190)	4.9 (L/165)	1.2 (L/145)	--	--
	4.27 (14)	18.5 (L/675)	13.4 (L/350)	8.3 (L/235)	3.3 (L/175)	--	--	--	--	--	--
	4.88 (16)	11.1 (L/445)	4.5 (L/230)	--	--	--	--	--	--	--	--

SI: 25.4 mm = 1 in, 1 N = 0.225 lb, 1 MPa = 145 psi

1. The specified wind pressures provided above are for ultimate limit states (ULS), which uses an importance factor of 1, and are used to determine the allowable axial load in accordance with NBC Division B Article 4.1.7.3. The deflection ratio is based on serviceability limit states (SLS) per NBC Article 4.1.3.5, which uses an importance factor of 0.75 when determining specified wind pressure.
2. LSL assumed to have a compression perpendicular to grain strength of 5.5 MPa.

5.2.5.6 Tstud™ used as headers in a wall have the following factored load capacities (Table 11).

Table 11. Factored Loads for Tstud™ as Headers[1,2,3]

Number of Members	Factored Header Load (kN/m) & (Deflection Ratio)							
	Header Span, m (ft)							
	0.61 (2)	0.91 (3)	1.22 (4)	1.52 (5)	1.83 (6)	2.13 (7)	2.44 (8)	2.74 (9)
1	5.2 (L/1367)	3.5 (L/609)	2.6 (L/342)	1.4 (L/320)	0.8 (L/320)	0.5 (L/320)	0.3 (L/320)	0.2 (L/320)
2	10.3 (L/1367)	6.9 (L/609)	5.2 (L/342)	2.8 (L/320)	1.6 (L/320)	1 (L/320)	0.7 (L/320)	0.5 (L/320)
3	15.5 (L/1367)	10.4 (L/609)	7.8 (L/342)	4.3 (L/320)	2.5 (L/320)	1.5 (L/320)	1 (L/320)	0.7 (L/320)
4	20.7 (L/1367)	13.8 (L/609)	10.4 (L/342)	5.7 (L/320)	3.3 (L/320)	2.1 (L/320)	1.4 (L/320)	1 (L/320)
5	25.9 (L/1367)	17.3 (L/609)	12.9 (L/342)	7.1 (L/320)	4.1 (L/320)	2.6 (L/320)	1.7 (L/320)	1.2 (L/320)

Number of Members	Factored Header Load (kN/m) & (Deflection Ratio)							
	Header Span, m (ft)							
	0.61 (2)	0.91 (3)	1.22 (4)	1.52 (5)	1.83 (6)	2.13 (7)	2.44 (8)	2.74 (9)
6	31 (L/1367)	20.7 (L/609)	15.5 (L/342)	8.5 (L/320)	4.9 (L/320)	3.1 (L/320)	2.1 (L/320)	1.5 (L/320)
7	36.2 (L/1367)	24.2 (L/609)	18.1 (L/342)	9.9 (L/320)	5.7 (L/320)	3.6 (L/320)	2.4 (L/320)	1.7 (L/320)
Values limited to serviceability limit state (deflection).								

SI: 25.4 mm = 1 in, 1 kN/m = 737.6 lb/ft

1. Table values are based on Tstud™ of No. 2 SPF lumber.
2. Table values are based on a load duration factor of 1.0.
3. Deflection checks of L/360 for live load and L/240 for total load are based on a live load to dead load ratio of 2:1, where L is equal to the header span.

5.2.6 *Use of T-Studs in Shear Walls:*

5.2.6.1 Tstud™ used in wall assemblies designed as shear walls are permitted to be designed in accordance with the methodology used in *CSA O86* Subsection 11.6.2[6] for wood structural panels using the seismic parameters shown in Table 12.

5.2.6.1.1 The ductility response modification factor, R_d, and overstrength-related force modification factor, R_o, indicated in Table 12 shall be used to determine the base shear, element design forces, and design story drift in accordance with *NBC* Division B Subsection 4.1.8.

Table 12. Seismic Design Coefficients for Tstud™ Shear Walls

Wall System	Ductility Factor, R_d[1,2]	Overstrength Force Modification Factor, R_o[2]	Structural Height Limits[3,4] (m)				
			$I_EF_aS_a(0.2)$				$I_EF_aS_a(1.0)$
			< 0.2	≥ 0.2 to < 0.35	≥ 0.35 to ≤ 0.75	> 0.75	> 0.3
Shear walls – Nailed shear walls wood-based panel	3.0	1.7	NL	NL	30	20	20

SI: 1 in = 25.4 mm, 1 lb/ft = 0.0146 kN/m

1. Response modification coefficient, R_d, for use throughout *NBC*.
2. For combinations of different types of SFRS acting in the same direction in the same storey, R_dR_o shall be taken as the lowest value of R_dR_o corresponding to these systems. See *NBC* Division B Subsection 4.1.8.9.
3. Consider the additional system restrictions in *NBC* Division B Subsection 4.1.8.10.
4. NL = Not Limited. Heights are maximum height limits above grade, as defines in *NBC* Division B Table 4.1.8.9.

5.3 For applications outside of the scope of the applicable code, consult the manufacturer installation instructions or a structural engineer registered in the province 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] 2014 *CSA O86* Subsection 11.5.1

6 Installation

6.1 Installation shall comply with the manufacturer installation instructions and this TER. In the event of a conflict between the manufacturer installation instructions and this TER, the more restrictive shall govern.

6.2 *Installation Procedure*

6.2.1 Tstud™ is pre-assembled and designed to be used as a direct replacement of nominal 2″ x 4″ (38 mm x 89 mm) solid sawn lumber, and in most cases, but not all, nominal 2″ x 6″ (38 mm x 140 mm) solid sawn lumber, as wall studs, top and bottom plates, and headers.

6.2.1.1 For use as a 2″ x 6″, design shall be permitted in accordance with accepted engineering procedures, experience, and technical judgment. In these cases, referenced design values as defined in Table 2 shall be used in accordance with *CSA O86* Section 15.3 and Clause 5.

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

6.2.2.1 For the *NBC* Section 4.3.1 and Section 9.23, install in accordance with the provisions therein, except as noted in this TER.

6.2.2.2 For engineered design, walls shall be designed in accordance with the *NBC, CSA O86,* and the standards referenced therein using the material properties and design limitations as noted in Section 5.

6.2.2.3 Design of connections using Tstud™ shall be in accordance with *CSA O86*.

6.2.3 Anchorage:

6.2.3.1 Stand walls and set into correct position. Ensure anchor bolts in foundation penetrate the center of the foam in the Tstud™ bottom plate.

6.2.3.2 Place metal plate over anchor bolts and fasten with a washer and nut. Once nut is tightened and the wall has been sufficiently anchored tight to the sill plate, drive four (4) 2½" #12 (0.216 dia.) screws (two [2] in each wood member) into the pre-drilled holes in the metal plate.

7 Substantiating Data

7.1 Testing has been performed under the supervision of a professional engineer and/or under the requirements of ISO/IEC 17025 as follows:

7.1.1 Compressive load testing of Tstud™

7.1.2 Bending tests in accordance with *ASTM D198*

7.1.3 Bending tests of Tstud™ top plates

7.1.4 Lateral load resistance in accordance with *ASTM E2126*

7.2 Information contained herein is the result of testing and/or data analysis by sources which conform to the evaluation requirements of *NBC* Volume 1 Relationship of the *NBC* to Standards Development and Conformity Assessment and/or professional engineering regulations. DrJ relies upon accurate data to perform its ISO/IEC 17065 evaluations.

7.3 Where appropriate, DrJ's analysis is based on provisions that have been codified into law through provincial, territorial, or local adoption of codes and standards. The providers of the codes and standards are legally responsible for their content. DrJ analysis may use code adopted provisions as a control sample. A control sample versus a test sample establishes a product as being equivalent to that prescribed in this code in quality, strength, effectiveness, fire resistance, durability and safety. Where the accuracy of the provisions provided herein is reliant upon the published properties of materials, DrJ relies upon the grade mark, grade stamp, mill certificate, and/or test data provided by material suppliers to be minimum properties. DrJ analysis relies upon these properties to be accurate.

8 Findings

8.1 Tstud™ insulated 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″ x 4″ (38 mm x 89 mm) solid sawn lumber in all cases and 2″ x 6″ (38 mm x 140 mm) solid sawn lumber in most cases for wall structural members.

8.1.1 For use as a 2" x 6", design shall be permitted in accordance with accepted engineering procedures, experience, and technical judgment. In these cases, referenced design values as defined in Table 2 shall be used in accordance with *NBC* Section 4.1 and Section 9.23.

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

8.2.1 No known variations

8.3 *NBC* Volume 1 Relationship of the NBC to Standards Development and Conformity Assessment:

> **Certification**
> Certification is the confirmation by an independent organization that a product, service, or system meets a requirement…Certification bodies publish lists of certified products and companies…Several organizations, including the Canadian Construction Materials Centre (CCMC), offer such evaluation services.
> **Evaluation**
> An evaluation is a written opinion by an independent professional organization that a product will perform its intended function. An evaluation is very often done to determine the ability of an innovative product, for which no standards exist, to satisfy the intent of the Code requirement...

8.4 ISO/IEC 17065 accreditation bodies, including but not limited to SCC and ANAB, confirm that product certification bodies have the expertise to provide *evaluation* services within their scope of accreditation. All SCC and ANAB product certification bodies meet *NBC* requirements to offer *evaluation* services for *alternative solutions*.[7]

8.4.1 DrJ is an ISO/IEC 17065 ANAB-Accredited Product Certification Body – Accreditation #1131 and employs professional engineers.[8]

8.5 Product certification organizations, accredited by the SCC and ANAB, are defined as equivalent *evaluation* services:

8.5.1 The Canada-United States-Mexico Agreement (CUSMA) Article 11.6 Conformity Assessment confirms mutual recognition by stating, "...each Party shall accord to conformity assessment bodies located in the territory of another Party treatment no less favorable than that it accords to conformity assessment bodies located in its own territory or in the territory of the other Party."

8.5.2 The SCC National Conformity Assessment Principles states, "SCC is a member of a number of international organizations developing voluntary conformity assessment agreements that help ensure the international acceptance of Canadian conformity assessment results. Signatories to these agreements (like SCC) recognize each other's accreditations as being equivalent to their own."[9]

8.6 Building official approval of a licensed professional engineer is performed by verifying the professional engineer and/or their business entity are listed by the licensing board of the relevant jurisdiction.

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[7] *NBC* Division A Clause A-1.2.1.1.(1)(b) provides information on code compliance via alternative solutions and defines alternative solutions as "...achiev[ing] at least the minimum level of performance required by Division B." *NBC* Division C Section 2.3 includes additional guidance for documentation of alternative solutions.

[8] Through ANAB accreditation and the IAF MLA, DrJ certification can be used to obtain material, product, design, or method of construction approval in any jurisdiction or country that has IAF MLA Members & Signatories to meet the Purpose of the MLA – "certified once, accepted everywhere."

[9] The National Conformity Assessment Principles states, "Product regulations and standards may vary from country to country. If these are set arbitrarily, they could be deemed as protectionist. The World Trade Organization (WTO) Agreement on Technical Barriers to Trade (TBT Agreement) is intended to ensure that technical regulations, standards and conformity assessment procedures of member countries do not create unnecessary obstacles to trade. Under the TBT Agreement, members of the WTO agree to use international standards, including conformity assessment standards and guides, as a basis for their technical requirements."

9 Conditions of Use

9.1 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 Tstud™ is 4.88 m (16 ft).

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 Where Tstud™ is used as a top plate, a separate means of fireblocking shall be provided in accordance with *NBC* Subsection 3.1.11.

9.3 Where required by the *authority having jurisdiction* (AHJ) where the project is to be constructed, this TER and the installation instructions shall be submitted at the time of permit application.

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

9.5 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 *designer* (e.g., *owner*).

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

9.7 This product has an internal quality control program and a third-party quality assurance program in accordance with ISO/IEC 17065 certification procedures.

9.8 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.

9.9 This TER shall be reviewed for code compliance by the AHJ in concert with the duties and powers granted to the building official by the provincial regulations governing such duties and powers.

9.10 The implementation of this TER for this product is dependent on the design, quality control, third-party quality assurance, proper implementation of installation instructions, inspections, and any other code or regulatory requirements that may apply.

10 Identification

10.1 The product listed in Section 1.1 is identified by a label on the board or packaging material bearing the manufacturer 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, visit drjcertification.org.

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

Appendix A: Tstud™ Example Calculation

Determine the factored axial load for a 2.4 m (8 ft) Tstud™ of No. 2 SPF lumber spaced 610 mm (24" o.c.) and subject to a specified wind pressure of 2.80 kPa (ULS) and 2.1 kPa (SLS).

$s := 610\ mm$	Stud spacing
$p_{uls} := 2.80\ kPa$	Specified wind pressure, ultimate limit state
$I_W := 0.75$	Importance factor for wind load, Normal, SLS
$p_{sls} := I_W \cdot p_{uls} = 2.1\ kPa$	Specified wind pressure, serviceability limit state
$w := 1.4 \cdot p_{uls} \cdot s = 2391\ \frac{N}{m}$	Factored wind load

Material Properties of Tstud™:

The material properties of the No. 2 SPF Tstud™ are given in Table 2 of the TER.

$f_b S := 2215\ N \cdot m$	Specified bending
$f_c := 11.5\ MPa$	Specified compression parallel to grain
$f_t := 5.5\ MPa$	Specified tension parallel to grain
$f_{cp} := 5.3\ MPa$	Specified compression perpendicular to grain
$V_c := 2630\ N$	Specified shear force
$EI := 86900\ N \cdot m^2$	Bending stiffness
$EI_{05} := 75600\ N \cdot m^2$	Bending stiffness for beam and column stability
$I := 9005799\ mm^4$	Moment of inertia
$E_{05} := \frac{EI_{05}}{I} = 8395\ MPa$	Modulus of elasticity for design of compression members

Section Properties of Tstud™:

$d := 5.5\ in = 140\ mm$	Effective depth of stud
$d_1 := 1.5\ in = 38\ mm$	Wide face dimension
$d_2 := 2.5\ in = 64\ mm$	Narrow face dimension
$d_{dowel} := \frac{11}{16}\ in = 17\ mm$	Dowel diameter
$A := (d_1 \cdot d_2) + ((d_2 - d_{dowel}) \cdot d_1) = 4173\ mm^2$	Net section area of Tstud™
$h := 2340\ mm = 8\ ft$	Height of Tstud™

Bending Moment Resistance:

$\phi := 0.90$	
$K_D := 1.15$	Load duration factor for short term
$K_H := 1.04$	System factor for load-sharing system

$K_{Sb} := 1.0$	Service condition factor for dry, bending at extreme fiber
$K_T := 1.0$	Treatment factor for untreated lumber products
$F_bS := f_bS \cdot (K_D \cdot K_H \cdot K_{Sb} \cdot K_T) = 2649\ N \cdot m$	
$K_{Zb} := 1.4$	Size factor in bending
$K_L := 1$	Lateral stability factor assuming lateral support
$M_r := \phi \cdot F_bS \cdot K_{Zb} \cdot K_L = 3338\ N \cdot m$	Bending moment resistance, CSA O86 Section 15.3.3.1

Compressive Resistance Parallel to Grain:

$\phi := 0.80$	
$K_e := 1.00$	Effective length factor
$K_D := 1.00$	Load duration factor for standard term
$K_{sc} := 1.00$	Service condition factor for dry, compression parallel to grain
$K_T := 1.0$	Treatment factor for untreated lumber products
$F_c := f_c \cdot (K_D \cdot K_{sc} \cdot K_T) = 11.5\ MPa$	
$K_{Zc} := 1.0$	Size factor for compression parallel to grain
$L_e := K_e \cdot h = 2340\ mm$	Effective length
$C_C := \frac{L_e}{d} = 17$	Slenderness ratio
$K_{SE} := 1.0$	Service condition factor for dry, MOE
$K_C := \left(1.0 + \frac{F_c \cdot K_{Zc} \cdot C_C^3}{35 \cdot E_{05} \cdot K_{SE} \cdot K_T}\right)^{-1} = 0.84$	Slenderness factor
$P_r := \phi \cdot F_c \cdot A \cdot K_C \cdot K_{Zc} = 32430\ N$	Factored compressive resistance parallel to grain, CSA O86 Section 15.3.3.4

Compressive Resistance Perpendicular to Grain:

$\phi := 0.80$	
$K_D := 1.00$	Load duration factor for standard term
$K_S := 1.0$	Service condition factor for dry service
$K_T := 1.0$	Treatment factor for untreated lumber products
$F_{cp} := f_{cp} \cdot (K_D \cdot K_S \cdot K_T)$	
$A_b := 2 \cdot d_1 \cdot d_2 = 4839\ mm^2$	Bearing area
$K_B := 1.13$	Length of bearing factor
$K_{Zcp} := 1$	Size factor for bearing
$Q_r := \phi \cdot F_{cp} \cdot A_b \cdot K_B \cdot K_{Zcp} = 23183\ N$	Compressive resistance perpendicular to grain, CSA O86 Section 15.3.3.6

Resistance to Combined Bending and Axial Load:

$P_f := 16.35\ kN = 16350\ N$	Factored axial load on the Tstud™ is selected to result in a CSI of 1.0.
$P_r := min(P_r, Q_r) = 23183\ N$	Check for failure in compression perpendicular to grain
$P_E := \frac{(\pi^2 \cdot E_{05} \cdot K_{SE} \cdot K_T \cdot I)}{L_e^2} = 136267\ N$	Euler buckling load in the plane of the applied moment
$M_f := \frac{(w \cdot h^2)}{8} = 1637\ N \cdot m$	Factored bending moment
$\left(\frac{P_f}{P_r}\right)^2 + \frac{M_f}{M_r} \cdot \left(\frac{1}{1 - \frac{P_f}{P_E}}\right) = 1 \quad \leq 1$ **OK**	Resistance to combined bending and axial load, CSA O86 Section 15.3.3.9

Deflection Limit:

$\Delta := \frac{5 \cdot (p_{sls} \cdot s) \cdot h^4}{384 \cdot EI} = 5.755\ mm$	Deflection

$\frac{h}{\Delta} = 407 \quad > \quad 240$ **OK**

Summary of Design Calculations for Tstud™:

The Tstud™ has a calculated axial load capacity of 23.2 kN for 2.44 m (8 ft) Tstud™ of No. 2 SPF lumber spaced 610 mm (24" o.c.) and subject to a wind pressure of 2.80 kPa. The axial load is limited by the compression strength of the Tstud™ member under combined axial and wind loading.