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Technical Evaluation Report™

TER 1409-01

EStud Structural Insulated Wall Stud

Lester Wilkens

Product:

EStud Structural Insulated Wall Stud

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SECTION: 06 10 00 - Rough Carpentry

DIVISION: 07 00 00 - THERMAL AND MOISTURE PROTECTION

SECTION: 07 21 00 - Thermal Insulation

SECTION: 07 21 13 - Foam Board Insulation

1 Innovative Product Evaluated[1,2]

1.1 EStud Structural Insulated Wall Stud

2 Applicable Codes and Standards[3,4]

2.1 *Codes*

2.1.1 *IBC—15, 18, 21: International Building Code®*

2.1.2 *IRC—15, 18, 21: 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 A653: Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process*

2.2.4 *ASTM C578: Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation*

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

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

2 24 CFR 3280.2 "Listed or certified" means included in a list published by a nationally recognized testing laboratory, inspection agency, or other organization concerned with product evaluation that maintains periodic inspection of production of listed equipment or materials, and whose listing states either that the equipment or material meets nationally recognized standards or has been tested and found suitable for use in a specified manner. **Listed**. Equipment, materials, products or services included in a list published by an organization acceptable to the building official and concerned with evaluation of products or services that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services and whose Listing states either that the equipment, material, product or service meets identified standards or has been tested and found suitable for a specified purpose. **Labeled.** Equipment, materials or products to which has been affixed a label, seal, symbol or other identifying mark of a nationally recognized testing laboratory, approved agency or other organization concerned with product evaluation that maintains periodic inspection of the production of the above-labeled items and whose labeling indicates either that the equipment, material or product meets identified standards or has been tested and found suitable for a specified purpose.

3 This Listing is a code defined research report, which is also known as a duly authenticated report, provided by an approved agency (see IBC Section 1703.1) and/or an approved source (see IBC Section 1703.4.2). An approved agency is "approved" as an approved agency when it is ANAB accredited. DrJ Engineering, LLC (DrJ) is listed in the ANAB directory). A professional engineer is "approved" as an approved source when that professional engineer is properly licensed to transact engineering commerce. Where sealed by a professional engineer, it is also a duly authenticated report certified by an approved source. (i.e., Registered Design Professional). DrJ is an ANAB accredited product certification body.

4 Unless otherwise noted, all references in this Listing are from the 2021 version of the codes and the standards referenced therein. This material, product, design, service and/or method of construction also complies with the 2000-2021 versions of the referenced codes and the standards referenced therein.

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

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

2.2.8 *TPI 1: National Design Standard for Metal-plate-connected Wood Truss Construction*

3 Performance Evaluation

3.1 Tests, testing, test reports, research reports, duly authenticated reports and related engineering evaluations are defined as intellectual property and/or trade secrets and protected by Defend Trade Secrets Act 2018 (DTSA).[5]

3.2 Testing and/or inspections conducted for this TER were performed an ISO/IEC 17025 accredited testing laboratory,[6] an ISO/IEC 17020 accredited inspection body,[7] which are internationally recognized accreditations through International Accreditation Forum (IAF), and/or a licensed Registered Design Professional (RDP).

3.3 EStud was evaluated to determine its applicability for use as an alternative material where nominal 2x4 solid sawn lumber is specified in accordance with the IBC and IRC.

3.4 EStud testing and analysis was conducted to determine its compression, flexural strengths, and flexural stiffness.

3.5 EStud was examined for the following:

3.5.1 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 2302.1[8] for allowable stress design (ASD) and load and resistance factor design (LRFD).

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

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

3.6 When used in an application that 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.

3.7 Any building code and/or accepted engineering evaluations (i.e. research reports, duly authenticated reports, etc.) that are conducted for this Listing were performed by DrJ Engineering, LLC (DrJ), an ISO/IEC 17065 accredited certification body and a professional engineering company operated by RDPs / approved sources. DrJ is qualified[9] to practice product and code compliance services within its scope of accreditation and engineering expertise, respectively.

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[5] https://www.law.cornell.edu/uscode/text/18/part-I/chapter-90. Whoever, with intent to convert a trade secret, that is related to a product or service used in or intended for use in or intended for use in interstate or foreign commerce, to the economic benefit or anyone other than the owner thereof, and intending or knowing that the offense will injure any owner of that trade secret, knowingly (1) steals, or without authorization appropriates, takes, carries away, or conceals, or by fraud, artifice, or deception obtains such information; (2) without authorization copies, duplicates, sketches, draws, photographs, downloads, uploads, alters, destroys, photocopies, replicates, transmits, delivers, sends, mails, communicates, or conveys such information; (3) receives, buys, or possesses such information, knowing the same to have been stolen or appropriated, obtained, or converted without authorization; (4) attempts to commit any offense described in paragraphs (1) through (3); or (5) conspires with one or more other persons to commit any offense described in paragraphs (1) through (3), and one or more of such persons do any act to effect the object of the conspiracy, shall, except as provided in subsection (b), be fined under this title or imprisoned not more than 10 years, or both. (b) Any organization that commits any offense described in subsection (a) shall be fined not more than the greater of $5,000,000 or 3 times the value of the stolen trade secret to the organization, including expenses for research and design and other costs of reproducing the trade secret that the organization has thereby avoided.
The federal government and each state have a public records act. As the National Society of Professional Engineers states, "Engineers shall not disclose, without consent, confidential information concerning the business affairs or technical processes of any present or former client or employer, or public body on which they serve." Therefore, to protect intellectual property (IP) and TS, and to achieve compliance with public records and trade secret legislation, requires approval through the use of Listings, certified reports, technical evaluation reports, duly authenticated reports and/or research reports prepared by approved agencies and/or approved sources.

[6] Internationally recognized accreditations are performed by members of the International Accreditation Forum (IAF). Accreditation Body and Regional Accreditation Group Members of IAF are admitted to the IAF MLA only after a stringent evaluation of their operations by a peer evaluation team, which is charged to ensure that the applicant complies fully with both international standards and IAF requirements. Once an accreditation body is a signatory of the IAF MLA, it is required to recognise certificates and validation and verification statements issued by conformity assessment bodies accredited by all other signatories of the IAF MLA, with the appropriate scope.

[7] Ibid.

[8] 2015 IBC Section 2301.2

[9] Qualification is performed by a legislatively defined Accreditation Body. ANSI National Accreditation Board (ANAB) is the largest independent accreditation body in North America and provides services in more than 75 countries. DrJ is an ANAB accredited product certification body.

3.8 Engineering evaluations are conducted with DrJ's ANAB accredited ICS code scope, which are also its areas of professional engineering competence.

3.9 Any regulation specific issues not addressed in this section are outside the scope of this TER.

4 Product Description and Materials

4.1 The EStud Structural Insulated Wall Stud evaluated in this TER is shown in Figure 1.

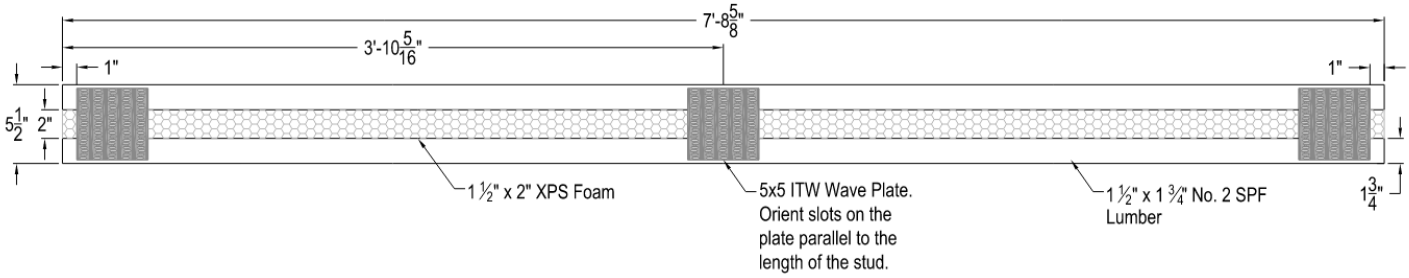

Figure 1. 8' EStud Construction Detail and Specifications

4.2 EStuds are made from a minimum of No. 2 Spruce-Pine-Fir (SPF) lumber and 2" (50.8 mm) extruded polystyrene (XPS) insulation.

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

4.2.2 The lumber is ripped length-wise into 1.75" wide (44.5 mm) members, and the XPS insulation is placed between sections of cut lumber.

4.2.3 After ripping, the lumber is re-graded to a minimum of #2 grade of the given species.

4.2.4 Lumber re-grading shall be performed by an American Lumber Standards Committee (ALSC) approved grading agency.

4.3 The XPS insulation is manufactured in accordance with ASTM C578 prior to EStud manufacture and is adhered to each section of the stud with a heat-resistant adhesive.

4.4 The adhesive used in the manufacturing process is a proprietary adhesive formulated specifically for bonding XPS insulation to wood surfaces.

4.5 Illinois Tool Works Building Components Group (ITWBCG), a.k.a. Alpine, 5" x 5", 20 gauge (36 mil) metal connector plates or equivalent are used to tie the stud assembly together with the lumber acting as tension and compression chords (Figure 1 and Figure 2).

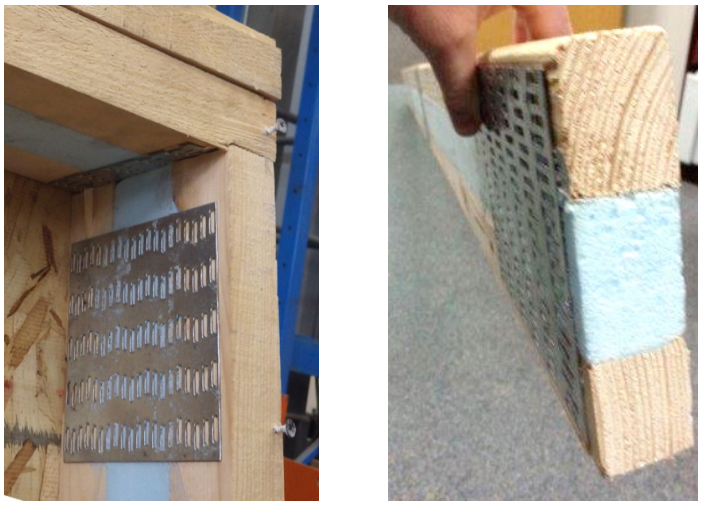

Figure 2. Metal Connector Plate (left) and EStud Cross Section (right)

4.5.1 Three (3) metal connector plates are installed on each wide face of the assembly (total 6 plates); one plate is placed at each end, and one is located in the center of the EStud length.

4.5.2 The plates at the ends are located 1" (25.4 mm) from the end of the EStud.

4.5.3 Plates shall be ITW wave plates or equivalent.

4.5.4 For top and bottom plate material, 2' x 5" metal connector plates are located 1" from each end and 12" on center along the plate material length.

4.6 *Materials*

4.6.1 *Lumber*

4.6.1.1 Grade: No. 2 SPF

4.6.1.2 Thickness: 1½" (38.1 mm)

4.6.1.3 Width: 1¾" (44.5 mm)

4.6.1.4 Lengths: 8', 9', and 10' (2.44 m, 2.74 m, and 3.05 m) nominal

4.6.2 *XPS Insulation*

4.6.2.1 The XPS insulation is manufactured in accordance with ASTM C578.

4.6.3 *Metal Connector Plates*

4.6.3.1 Metal connector plates used in EStud are manufactured in accordance TPI 1 Chapter 4.

4.6.3.2 Metal connector plates shall be made of 20 gauge (36 mil) ASTM A653, SS Grade 40 structural steel.

4.6.3.3 Metal connector plates shall have a minimum G60 galvanized coating (0.0005" thickness on each side).

5 Applications

5.1 *Prescriptive Provisions*

5.1.1 EStud is an alternative to solid sawn lumber for wall structural members.

5.1.1.1 EStud is an acceptable replacement to nominal 2x4 solid sawn lumber in accordance with IBC Section 2308 and IRC Section R602.

5.1.2 XPS insulation is in accordance with IBC Chapter 26, IBC Section 2603.2, IBC Section 2603.3, IBC Section 2603.4 and IRC Section R316, specifically IRC Section R316.2, IRC Section R316.3, and IRC Section R316.4.

5.1.3 Metal connector plates used are per TPI 1 Chapter 4, Section 4.3.3 and 4.3.4.

5.1.4 *Cutting, Notching, and Boring:*

5.1.4.1 Cross cutting EStuds is permitted. Where EStuds are cross cut such that a metal connector plate is not within 3" (76.2 mm) of the EStud end, one of the following shall be done:

5.1.4.1.1 The EStud chords must be nailed to another framing member.

5.1.4.1.2 A metal connector plate shall be field applied to connect the EStud chords, as shown in Figure 1.

5.1.4.2 Notches in structural members (chords or plates) are not permitted.

5.1.4.3 Holes may only be bored in the XPS insulation of EStud and shall not exceed 2" (50.8 mm) in diameter.

5.1.4.4 Holes shall not be bored in metal connector plates.

5.1.5 EStud used as structural members of a wall shall be fastened as specified in Table 1.

Table 1. Acceptable Fastening Schedule for 2x4 EStud

Application[2]	Number & Type of Fastener	Fastener Spacing
Ceiling Joists to Plate (toe nail)	4 (2½" × 0.113")	2 toe nails into each chord
Rafter or Roof Truss to Plate (toe nail)	4 (3" × 0.128")	2 toe nails into each chord[1]
Built-up Studs (face nail)	(3" × 0.128")	1 nail into each chord at 16" o.c.
Abutting Studs at Intersecting Wall Corners (face nail)	(3¼" × 0.131")	1 nail into each chord at 12" o.c.
Double Studs (face nail)	(3" × 0.128")	1 nail into each chord at 16" o.c.
Double Top Plates (face nail)	(3" × 0.128")	1 nail into each chord at 12" o.c.
Double Top Plates, Minimum 24" Offset of End Joints, Face Nail in Lapped Area	18 (3" × 0.128")	9 nails into each chord
Stud to Plate (toe nail)	4 (2½" × 0.113")	2 toe nails into each chord
Top or Sole Plate to Stud (end nail)	2 (3½" × 0.162") or 4 (3" × 0.128")	1 nails into each chord or 2 nails into each chord
Top Plates, Laps at Corners & Intersections (face nail)	4 (3" × 0.128")	2 nails into each chord

SI: 1" = 25.4 mm

1. 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.
2. For all connections, care must be taken to avoid splitting of EStud chords.

5.1.6 EStud may be used as a top plate in accordance with IRC Section R602.3.2 and the following:

5.1.6.1 Top plate design shall include 2" x 5" metal plates spaced every 12" (305 mm) o.c., starting no more than 12" (305 mm) from each end of the board to allow the top plates to be cut to custom lengths in the field, while maintaining a metal plate within 12" (305 mm) of each end.

5.1.6.2 Fasteners for EStud connections shall be evenly distributed in each EStud chord (i.e., top plate to stud connections shall have one fastener installed in each EStud chord).

5.1.6.3 Double top plates must be used on all walls.

5.1.7 Use as jack, trimmer, and cripple studs is acceptable, provided at least two (2) metal connector plates are attached on each side of the stud, no less than 1" (25.4 mm) from the ends.

5.1.7.1 If cut in the field to accommodate sizing, EStud must be fastened to a double stud through its face with, at a minimum, 10d (3" x 0.128") nails 16" (610 mm) o.c. into each chord.

5.1.7.2 When used as a jack stud, EStud must be fastened to a king stud.

5.1.7.3 When used as a cripple stud, one (1) nail must be driven through the window sill plate into each end of the EStud structural members.

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

5.1.9 Trusses and rafters having a maximum reaction of 2,789 lbs. may be placed anywhere on walls with double EStud top plates.

5.1.9.1 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 limit of 2,789 lbs. per ply (i.e., 5,578 lbs. per 2-ply built-up stud). In this case, the built-up stud shall be located directly under the applied load.

5.1.9.2 Walls with nominal 2x6 lumber top plates shall be in accordance with IRC Section R602.3.2.

5.2 *Engineering Design*

5.2.1 The design provisions for wood construction noted in IBC Section 2301.2 and IRC Section R301.1.3 apply to EStud for allowable stress design (ASD), unless otherwise noted in this TER.

5.2.2 *Material Properties:*

5.2.2.1 Reference design values for EStud are specified in Table 2.

Table 2. EStud Reference Design Values

Property	Value
F_b	875 psi
F_c	1,150 psi
F_t	450 psi
$F_{c\perp}$	425 psi
EI	8,400,000 lb-in^2
EI_{min}	3,100,000 lb-in^2
SI: 1 psi = 0.00689 MPa	

5.2.2.2 Reference design values for EStud shall be multiplied by the applicable adjustment factors specified in NDS Section 4.3.

5.2.3 *Design for Axial Loads:*

5.2.3.1 The maximum allowable compression load for EStud is specified in Table 3.

5.2.3.2 The maximum allowable compression load is based on perpendicular-to-grain crushing of SPF top and bottom plates.

5.2.3.3 The allowable axial compression for EStud can be calculated using the provisions of NDS Section 3.6 and 3.7.

5.2.3.4 For computing the column stability factor, the critical bucking design value, F_{cE}, shall be computed using the formula:

$$F_{cE} = \frac{\pi^2 E I_{min}}{A(\ell_e)^2}$$

Where:

A = total cross-sectional area of EStud (wood only) = 2 x 1.5" x 1.75" = 5.25 in^2

(for SI: 2 x 38.1 mm x 44.5 mm = 3391 mm^2)

Table 3. EStud Maximum Allowable Compression

EStud Length (ft)	Load (lb)
8	2,789
9	2,511
≤ 10	2,073
SI: 1" = 25.4 mm, 1 lb = 4.45 N	

5.2.4 *Design for Bending:*

5.2.4.1 EStud resists bending using tension and compression stresses in the chord members and bending in the chord member on the side of the EStud to which the loads are applied.

5.2.4.2 The axial stresses in each member can be computed using the following equation:

$$f_a = \frac{M}{0.5 \cdot A \cdot d_{eff}}$$

Where:

M = bending moment applied to EStud (lb-in)

A = cross-sectional area of EStud chord = 1.5" x 1.75" = 2.625 in^2

(for SI: 38.1 mm x 44.5 mm = 1695 mm^2)

d_{eff} = distance from center-to-center of EStud members = 3.75" (95.3 mm)

5.2.4.3 The bending stress in the member on the side of the EStud to which the loads are applied shall be calculated using NDS Section 3.3 as follows:

$$f_b = \frac{6M}{bd^2}$$

Where:

M = moment due to bending of the EStud member between metal connector plates = $\frac{\omega \ell^2}{12}$

ℓ = center-to-center spacing of metal connector plates

b = width of EStud members = 1.5" (38.1 mm)

d = depth of EStud members = 1.75" (44.5 mm)

5.2.4.4 The combined axial and bending stresses in EStud members shall be checked in accordance with NDS Section 3.9.

5.2.5 *Design for Combined Bending and Axial Loads:*

5.2.5.1 Stresses due to axial loading of EStud shall be added to the axial stress due to bending and checked in accordance with NDS Section 3.9.

5.2.5.2 Allowable axial load values for EStud subject to ASD wind pressures are specified in Table 4.

5.2.5.3 Example design calculations for EStud subject to combined bending and axial loads can be found in Appendix B.

Table 4. Allowable Axial Loads & Deflection Ratio for ASD wind loading

Stud Spacing (in)	Wall Height (ft)	Allowable Axial Load, lb (Deflection Ratio)							
		ASD Wind Pressure (psf)							
		5	10	15	20	25	30	35	40
12	8	2789 (L/1948)	2555 (L/974)	2263 (L/649)	1985 (L/487)	1718 (L/390)	1457 (L/325)	1202 (L/278)	951 (L/244)
	9	2160 (L/1352)	1798 (L/676)	1464 (L/451)	1144 (L/338)	833 (L/270)	529 (L/225)	229 (L/193)	–
	10	1622 (L/976)	1214 (L/488)	832 (L/325)	463 (L/244)	102 (L/195)	–	–	–
16	8	2764 (L/1461)	2358 (L/731)	1985 (L/487)	1630 (L/365)	1287 (L/292)	951 (L/244)	621 (L/209)	295 (L/183)
	9	2035 (L/1014)	1574 (L/507)	1144 (L/338)	731 (L/253)	328 (L/203)	–	–	–
	10	1482 (L/732)	958 (L/366)	463 (L/244)	–	–	–	–	–
24	8	2484 (L/974)	1878 (L/487)	1321 (L/325)	787 (L/244)	268 (L/195)	–	–	–
	9	1732 (L/676)	1044 (L/338)	400 (L/225)	–	–	–	–	–
	10	1152 (L/488)	369 (L/244)	–	–	–	–	–	–

SI: 1" = 25.4 mm, 1 lb = 4.45 N, 1 psf = 0.0479 kN/m^2

5.3 For applications outside of the scope of the applicable code, consult the manufacturer installation instructions or an RDP.

5.4 Where the application falls outside of the performance evaluation, conditions of use and/or installation requirements set forth herein, alternative techniques shall be permitted in accordance with accepted engineering practice and experience. This includes but is not limited to the following areas of engineering: mechanics or materials, structural, building science, and fire science.

6 Installation

6.1 Installation shall comply with the approved construction documents, the manufacturer installation instructions, this TER and the applicable building code.

6.2 In the event of a conflict between the manufacturer installation instructions and this TER, the more restrictive shall govern.

6.3 *Installation Procedure*

6.3.1 EStud is pre-assembled and designed to be used as a direct replacement of nominal 2x4 (38 mm x 89 mm) solid sawn lumber as wall studs and top plates.

6.3.2 Install EStud in the same manner as solid sawn lumber, except as noted herein.

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

6.3.2.2 For engineered design, walls shall be designed in accordance with the IBC and the referenced standards therein using the material properties and design limitations as noted in Section 5.

6.4 Design of connections using EStud shall be in accordance with NDS.

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 Bending testing of EStuds and EStud Top Plates in accordance with ASTM D198

7.1.2 Cyclic shear resistance testing of WSP shear walls with EStud framing in accordance with ASTM E2126

7.1.3 Compression testing of EStuds in accordance with ASTM E72

7.2 Information contained herein may include the result of testing and/or data analysis by sources that are approved agencies (i.e., ANAB accredited agencies), approved sources (i.e., RDPs), and/or professional engineering regulations. Accuracy of external test data and resulting analysis is relied upon.

7.3 Where pertinent, testing and/or engineering analysis is based upon provisions that have been codified into law through state or local adoption of codes and standards. The developers of these codes and standards are responsible for the reliability of published content. DrJ's engineering practice may use a code-adopted provision as the control sample. A control sample versus a test sample establishes a product as being equivalent to the code-adopted provision in terms of quality, strength, effectiveness, fire resistance, durability, and safety.

7.4 The accuracy of the provisions provided herein may be reliant upon the published properties of raw materials, which are defined by the grade mark, grade stamp, mill certificate, Listings, certified reports, duly authenticated reports from approved agencies, and research reports prepared by approved agencies and/or approved sources provided by the suppliers of products, materials, designs, assemblies and/or methods of construction. These are presumed to be minimum properties and relied upon to be accurate. The reliability of DrJ's engineering practice, as contained in this TER, may be dependent upon published design properties by others.

7.5 Testing and engineering analysis: The strength, rigidity and/or general performance of component parts and/or the integrated structure are determined by suitable tests that simulate the actual conditions of application that occur and/or by accepted engineering practice and experience.[10]

7.6 Where additional condition of use and/or code compliance information is required, please search for EStud Structural Insulated Wall Stud on the DrJ Certification website.

8 Findings

8.1 As delineated in Section 3, EStud Structural Insulated Wall Stud has performance characteristics that were tested and/or meet pertinent standards and is suitable for use pursuant to its specified purpose.

8.2 When used and installed in accordance with this TER and the manufacturer installation instructions, EStud Structural Insulated Wall Stud shall be approved for the following applications:

8.2.1 For use as an alternative to nominal 2x4 (38 mm x 89 mm) solid sawn lumber.

8.3 Any application specific issues not addressed herein can be engineered by an RDP. Assistance with engineering is available from Lester Wilkens.

8.4 IBC Section 104.11 (IRC Section R104.11 and IFC Section 104.10[11] are similar) in pertinent part 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. 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.

8.5 **Approved**:[12] Building codes require that the building official shall accept duly authenticated reports[13] or research reports[14] from approved agencies and/or approved sources (i.e., licensed RDP) with respect to the quality and manner of use of new products, materials, designs, services, assemblies, or methods of construction.

8.5.1 Acceptability of an approved agency, by a building official, is performed by verifying that the agency is accredited by a recognized accreditation body of the International Accreditation Forum (IAF).

8.5.2 Acceptability of a licensed RDP, by a building official, is performed by verifying that the RDP and/or their business entity is listed by the licensing board of the relevant jurisdiction.

8.5.3 Federal law, Title 18 US Code Section 242, requires that where the alternative product, material, service, design, assembly, and/or method of construction is not approved, the building official shall respond in writing, stating the reasons why the alternative was not approved, as denial without written reason deprives a protected right to free and fair competition in the marketplace.

8.6 DrJ is an engineering company, employs RDPs and is an ISO/IEC 17065 ANAB-Accredited Product Certification Body – Accreditation #1131.

8.7 Through ANAB accreditation and the IAF Multilateral Agreements, this TER 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*." IAF specifically says, "*Once an accreditation body is a signatory of the IAF MLA, it is required to recognise certificates and validation and verification statements issued by conformity assessment bodies accredited by all other signatories of the IAF MLA, with the appropriate scope*."[15]

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[10] See Code of Federal Regulations (CFR) Title 24 Subtitle B Chapter XX Part 3280 for definition.

[11] 2018 IFC Section 104.9

[12] Approved is an adjective that modifies the noun after it. For example, Approved Agency means that the Agency is accepted officially as being suitable in a particular situation. This example conforms to IBC/IRC/IFC Section 201.4 where the building code authorizes sentences to have an ordinarily accepted meaning such as the context implies.

[13] https://up.codes/viewer/wyoming/ibc-2021/chapter/17/special-inspections-and-tests#1707.1

[14] https://up.codes/viewer/wyoming/ibc-2021/chapter/17/special-inspections-and-tests#1703.4.2

[15] https://iaf.nu/en/about-iaf-mla/#:~:text=required%20to%20recognise

9 Conditions of Use

9.1 Material properties shall not fall outside the boundaries defined in Section 3.

9.2 As defined in Section 3, where material and/or engineering mechanics properties are created for load resisting design purposes, the resistance to the applied load shall not exceed the ability of the defined properties to resist those loads using the principles of accepted engineering practice.

9.3 The manufacturer published installation instructions shall be available at the jobsite at all times during installation.

9.4 EStud is a suitable alternative to 2x4 sawn lumber as permitted by the codes listed in Section 2 subject to the following conditions:

9.4.1 Metal connector plates must not be removed.

9.4.1.1 If metal connector plates are missing upon arrival, not applied correctly from the distributor, or fall off during installation, the stud shall be replaced.

9.4.2 EStud may not be used as a bottom plate where fixture to a sill plate and anchor bolts is required.

9.4.3 EStud may not be used as a stud pack where hold-downs are required for engineered design.

9.4.4 The maximum wall height for EStud is 10' (3.05 m).

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

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

9.5 When required by adopted legislation and enforced by the building official, also known as the authority having jurisdiction (AHJ) in which the project is to be constructed:

9.5.1 Any calculations incorporated into the construction documents shall conform to accepted engineering practice, and, when prepared by an approved source, shall be approved when requirements of adopted legislation are met.

9.5.2 This TER and the installation instructions shall be submitted at the time of permit application.

9.5.3 This EStud Structural Insulated Wall Stud has an internal quality control program and a third-party quality assurance program.

9.5.4 At a minimum, this EStud Structural Insulated Wall Stud shall be installed per Section 6 of this TER.

9.5.5 The review of this TER, by the AHJ, shall be in compliance with IBC Section 104 and IBC Section 105.4.

9.5.6 This EStud Structural Insulated Wall Stud has an internal quality control program and a third party quality assurance program in accordance with IBC Section 104.4, IBC Section 110.4, IBC Section 1703, IRC Section R104.4 and IRC Section R109.2.

9.5.7 The application of this EStud Structural Insulated Wall Stud in the context of this TER is dependent upon the accuracy of the construction documents, implementation of installation instructions, inspection as required by IBC Section 110.3, IRC Section R109.2 and any other regulatory requirements that may apply.

9.6 The approval of this TER by the AHJ shall comply with IBC Section 1707.1, where legislation states in pertinent part, "*the building official shall accept duly authenticated reports from approved agencies in respect to the quality and manner of use of new materials or assemblies as provided for in Section 104.11*", all of IBC Section 104, and IBC Section 105.4.

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 (i.e., owner or RDP).

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.

10 Identification

10.1 The EStud Structural Insulated Wall Stud 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 by contacting Lester Wilkens at lbwilkens@hotmail.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 status of this TER, contact DrJ Certification.

12 Approved for Use Pursuant to US and International Legislation Defined in Appendix A

12.1 EStud Structural Insulated Wall Stud is included in this TER published by an approved agency that is concerned with evaluation of products or services, maintains periodic inspection of the production of listed materials or periodic evaluation of services, and whose TER Listing states either that the material, product, or service meets identified standards or has been tested and found suitable for a specified purpose. This TER meets the legislative intent and definition of being acceptable to the AHJ.

Appendix A

1 Legislation that Authorizes AHJ Approval

1.1 **Fair Competition**: State legislatures have adopted Federal regulations for the examination and approval of building code referenced and alternative products, materials, designs, services, assemblies and/or methods of construction that:

1.1.1 Advance Innovation,

1.1.2 Promote competition so all businesses have the opportunity to compete on price and quality in an open market on a level playing field unhampered by anticompetitive constraints, and

1.1.3 Benefit consumers through lower prices, better quality, and greater choice.

1.2 **Adopted Legislation**: The following local, state, and federal regulations affirmatively authorize EStud Structural Insulated Wall Stud to be approved by AHJs, delegates of building departments, and/or delegates of an agency of the federal government:

1.2.1 Interstate commerce is governed by the Federal Department of Justice to encourage the use of innovative products, materials, designs, services, assemblies and/or methods of construction. The goal is to "protect economic freedom and opportunity by promoting free and fair competition in the marketplace."

1.2.2 Title 18 US Code Section 242 affirms and regulates the right of individuals and businesses to freely and fairly have new products, materials, designs, services, assemblies and/or methods of construction approved for use in commerce. Disapproval of alternatives shall be based upon non-conformance with respect to specific provisions of adopted legislation, and shall be provided in writing stating the reasons why the alternative was not approved, with reference to the specific legislation violated.

1.2.3 The federal government and each state have a public records act. In addition, each state also has legislation that mimics the federal Defend Trade Secrets Act 2018 (DTSA).

1.2.3.1 Compliance with public records and trade secret legislation requires approval through the use of listings, certified reports, Technical Evaluation Reports, duly authenticated reports and/or research reports prepared by approved agencies and/or approved sources.

1.2.4 For new materials[16] that are not specifically provided for in any building code, the design strengths and permissible stresses shall be established by tests, where suitable load tests simulate the actual loads and conditions of application that occur.

1.2.5 The design strengths and permissible stresses of any structural material shall conform to the specifications and methods of design using accepted engineering practice.[17]

1.2.6 The commerce of approved sources (i.e., registered PEs) is regulated by professional engineering legislation. Professional engineering commerce shall always be approved by AHJs, except where there is evidence, provided in writing, that specific legislation has been violated by an individual registered PE.

1.2.7 The AHJ shall accept duly authenticated reports from approved agencies in respect to the quality and manner of use of new materials or assemblies as provided for in IBC Section 104.11.[18]

[16] https://up.codes/viewer/wyoming/ibc-2021/chapter/17/special-inspections-and-tests#1706.2

[17] IBC 2021, Section 1706.1 Conformance to Standards

[18] IBC 2021, Section 1707 Alternative Test Procedure, 1707.1 General

1.3 **Approved**[19] **by Los Angeles**: The Los Angeles Municipal Code (LAMC) states in pertinent part that the provisions of LAMC are not intended to prevent the use of any material, device, or method of construction not specifically prescribed by LAMC. The Department shall use Part III, Recognized Standards in addition to Part II, Uniform Building Code Standards of Division 35, Article 1, Chapter IX of the LAMC in evaluation of products for approval where such standard exists for the product or the material and may use other approved standards, which apply. Whenever tests or certificates of any material or fabricated assembly are required by Chapter IX of the LAMC, such tests or certification shall be made by a testing agency approved by the Superintendent of Building to conduct such tests or provide such certifications. The testing agency shall publish the scope and limitation(s) of the listed material or fabricated assembly.[20] The Superintendent of Building roster of approved testing agencies is provided by the Los Angeles Department of Building and Safety (LADBS). The Center for Building Innovation (CBI) Certificate of Approval License is TA24945. Tests and certifications found in a CBI Listing are LAMC approved. In addition, the Superintendent of Building shall accept duly authenticated reports from approved agencies in respect to the quality and manner of use of new materials or assemblies as provided for in the California Building Code (CBC) Section 1707.1.[21]

1.4 **Approved by Chicago**: The Municipal Code of Chicago (MCC) states in pertinent part that an Approved Agency is a Nationally Recognized Testing Laboratory (NRTL) acting within its recognized scope and/or a certification body accredited by the American National Standards Institute (ANSI) acting within its accredited scope. Construction materials and test procedures shall conform to the applicable standards listed in the MCC. Sufficient technical data shall be submitted to the building official to substantiate the proposed use of any product, material, service, design, assembly and/or method of construction not specifically provided for in the MCC. This technical data shall consist of research reports from approved sources (i.e., MCC defined Approved Agencies).

1.5 **Approved by New York City**: The NYC Building Code 2022 (NYCBC) states in pertinent part that an approved agency shall be deemed[22] an approved testing agency via ISO/IEC 17025 accreditation, an approved inspection agency via ISO/IEC 17020 accreditation, and an approved product evaluation agency via ISO/IEC 17065 accreditation. Accrediting agencies, other than federal agencies, must be members of an internationally recognized cooperation of laboratory and inspection accreditation bodies subject to a mutual recognition agreement[23] (i.e., ANAB, International Accreditation Forum (IAF), etc.).

1.6 **Approved by Florida**: Statewide approval of products, methods, or systems of construction shall be approved, without further evaluation, by 1) A certification mark or listing of an approved certification agency, 2) A test report from an approved testing laboratory, 3) A product evaluation report based upon testing or comparative or rational analysis, or a combination thereof, from an approved product evaluation entity; 4) A product evaluation report based upon testing or comparative or rational analysis, or a combination thereof, developed and signed and sealed by a professional engineer or architect, licensed in Florida. For local product approval, products or systems of construction shall demonstrate compliance with the structural wind load requirements of the Florida Building Code (FBC) through one of the following methods; 1) A certification mark, listing, or label from a commission-approved certification agency indicating that the product complies with the code; 2) A test report from a commission-approved testing laboratory indicating that the product tested complies with the code; 3) A product-evaluation report based upon testing, comparative or rational analysis, or a combination thereof, from a commission-approved product evaluation entity which indicates that the product evaluated complies with the code; 4) A product-evaluation report or certification based upon testing or comparative or rational analysis, or a combination thereof, developed and signed and sealed by a Florida professional engineer or Florida registered architect, which indicates that the product complies with the code; 5) A statewide product approval issued by the Florida Building Commission. The Florida Department of Business and Professional Regulation (DBPR) website provides a listing of companies certified as a Product Evaluation Agency (i.e., EVLMiami 13692), a Product Certification Agency (i.e., CER10642), and as a Florida Registered Engineer (i.e., ANE13741).

[19] See Section 8 for the distilled building code definition of **Approved**

[20] Los Angeles Municipal Code, SEC. 98.0503. TESTING AGENCIES

[21] https://up.codes/viewer/california/ca-building-code-2022/chapter/17/special-inspections-and-tests#1707.1

[22] New York City, The Rules of the City of New York, § 101-07 Approved Agencies

[23] New York City, The Rules of the City of New York, § 101-07 Approved Agencies

1.7 **Approved by Miami-Dade County (i.e., Notice of Acceptance [NOA])**: A Florida statewide approval is an NOA. An NOA is a Florida local product approval. By Florida law, Miami-Dade County shall accept the statewide and local Florida Product Approval as provided for in Florida legislation 553.842 and 553.8425.

1.8 **Approved by New Jersey**: Pursuant to Building Code 2018 of New Jersey in IBC Section 1707.1 General,[24] it states: "In the absence of approved rules or other approved standards, the building official shall accept duly authenticated reports from approved agencies in respect to the quality and manner of use of new materials or assemblies as provided for in the administrative provisions of the Uniform Construction Code (N.J.A.C. 5:23)".[25] Furthermore N.J.A.C 5:23-3.7 states: Municipal approvals of alternative materials, equipment, or methods of construction. **(a) Approvals**: Alternative materials, equipment, or methods of construction shall be approved by the appropriate subcode official provided the proposed design is satisfactory and that the materials, equipment, or methods of construction are suitable for the intended use and are at least the equivalent in quality, strength, effectiveness, fire resistance, durability and safety of those conforming with the requirements of the regulations. 1. A field evaluation label and report or letter issued by a nationally recognized testing laboratory verifying that the specific material, equipment, or method of construction meets the identified standards or has been tested and found to be suitable for the intended use, shall be accepted by the appropriate subcode official as meeting the requirements of (a) above. 2. Reports of engineering findings issued by nationally recognized evaluation service programs, such as, but not limited to, the Building Officials and Code Administrators (BOCA), the International Conference of Building Officials (ICBO), the Southern Building Code Congress International (SBCCI), the International Code Council (ICC), and the National Evaluation Service, Inc., shall be accepted by the appropriate subcode official as meeting the requirements of (a) above. The New Jersey Department of Community Affairs has confirmed that technical evaluation reports, from any accredited entity listed by ANAB, meets the requirements of item 2 given that the listed entities are no longer in existence and/or do not provide "reports of engineering findings".

1.9 **Approved by the Code of Federal Regulations Manufactured Home Construction and Safety Standards**: Pursuant to Title 24, Subtitle B, Chapter XX, Part 3282.14[26] and Part 3280,[27] the Department encourages innovation and the use of new technology in manufactured homes. The design and construction of a manufactured home shall conform with the provisions of Part 3282 and Part 3280 where key approval provisions in mandatory language follow: 1) "All construction methods shall be in conformance with accepted engineering practices"; 2) "The strength and rigidity of the component parts and/or the integrated structure shall be determined by engineering analysis or by suitable load tests to simulate the actual loads and conditions of application that occur."; and 3) "The design stresses of all materials shall conform to accepted engineering practice."

1.10 **Approval by US, Local, and State Jurisdictions in General**: In all other local and state jurisdictions, the adopted building code legislation states in pertinent part that:

1.10.1 For new materials that are not specifically provided for in this code, the design strengths and permissible stresses shall be established by tests.[28]

1.10.2 For innovative alternative products, materials, designs, services and/or methods of construction, in the absence of approved rules or other approved standards…the building official shall accept duly authenticated reports (i.e., listing and/or research report) from approved agencies with respect to the quality and manner of use of new materials or assemblies.[29] A building official approved agency is deemed to be approved via certification from an accreditation body that is listed by the International Accreditation Forum[30] or equivalent.

[24] https://up.codes/viewer/new_jersey/ibc-2018/chapter/17/special-inspections-and-tests#1707.1

[25] https://www.nj.gov/dca/divisions/codes/codreg/ucc.html

[26] https://www.ecfr.gov/current/title-24/subtitle-B/chapter-XX/part-3282/subpart-A/section-3282.14

[27] https://www.ecfr.gov/current/title-24/subtitle-B/chapter-XX/part-3280

[28] IBC 2021, Section 1706 Design Strengths of Materials, 1706.2 New Materials. Adopted law pursuant to IBC model code language 1706.2.

[29] IBC 2021, Section 1707 Alternative Test Procedure, 1707.1 General. Adopted law pursuant to IBC model code language 1707.1.

[30] Please see the ANAB directory for building official approved agencies.

1.10.3 The design strengths and permissible stresses of any structural material…shall conform to the specifications and methods of design of accepted engineering practice performed by an approved source.[31] An approved source is defined as a PE subject to professional engineering laws, where a research and/or a technical evaluation report certified by a PE, shall be approved.

1.11 **Approval by International Jurisdictions**: The USMCA and GATT agreements provide for approval of innovative materials, products, designs, services, assemblies and/or methods of construction through the Technical Barriers to Trade agreements and the International Accreditation Forum (IAF) Multilateral Recognition Arrangement (MLA), where these agreements:

1.11.1 Permit participation of conformity assessment bodies located in the territories of other Members (defined as GATT Countries) under conditions no less favourable than those accorded to bodies located within their territory or the territory of any other country,

1.11.2 State that conformity assessment procedures (i.e., ISO/IEC 17020, 17025, 17065, etc.) are prepared, adopted, and applied so as to grant access for suppliers of like products originating in the territories of other Members under conditions no less favourable than those accorded to suppliers of like products of national origin or originating in any other country, in a comparable situation.

1.11.3 State that conformity assessment procedures are not prepared, adopted, or applied with a view to or with the effect of creating unnecessary obstacles to international trade. This means that conformity assessment procedures shall not be more strict or be applied more strictly than is necessary to give the importing Member adequate confidence that products conform to the applicable technical regulations or standards.

1.11.4 **Approved**: The purpose of the IAF MLA is to ensure mutual recognition of accredited certification and validation/verification statements between signatories to the MLA, and subsequently acceptance of accredited certification and validation/verification statements in many markets based on one accreditation for the timely approval of innovative materials, products, designs, services, assemblies and/or methods of construction. Accreditations granted by IAF MLA signatories are recognised worldwide based on their equivalent accreditation programs, therefore reducing costs and adding value to businesses and consumers.

[31] IBC 2021, Section 1706 Design Strengths of Materials, Section 1706.1 Conformance to Standards Adopted law pursuant to IBC model code language 1706.1.

Appendix B

EStud Example Calculation

Material Properties of EStud:

The EStud uses SPF lumber graded as No.2.

$F_c := 1150\ psi$ $F_b := 875\ psi$ $F_t := 450\ psi$

$C_{fc} := 1.15$ $C_{fb} := 1.5$ $C_{ft} := 1.5$

$F_{c\_perp} := 425\ psi$

$EI := 8400000\ lbf \cdot in^2$

$EI_{min} := 3100000\ lbf \cdot in^2$

Section Properties of EStud:

$d_1 := 1.75\ in$ Wide face dimension.

$d_2 := 1.5\ in$ Narrow face dimension.

$d_{eff} := 3.75\ in$ Moment arm between members.

$A := d_1 \cdot d_2 \cdot 2 = 5.25\ in^2$ Area of EStud.

$l_1 := 92.625\ in$ Height of EStud.

$l_3 := \frac{l_1 - 7\ in}{2} = 42.813\ in$ On center spacing of truss plates.

Calculate allowable stresses for the EStud:

$C_D := 1.6$

$C_r := 1.5$ Repetitive member factor for studs is 1.5 per SDPWS Section 3.1.1 for studs spaced 16" o.c. or less. For stud spacing greater than 16" o.c., the repetitive member factor is 1.15 per the NDS.

$C_b := \frac{d_2 + 0.375\ in}{d_2} = 1.25$

$F_t' := F_t \cdot C_D \cdot C_{ft} = 1080\ psi$

$F_b' := F_b \cdot C_D \cdot C_{fb} \cdot C_r = 3150\ psi$

$F_{c\_star} := F_c \cdot C_{fc} \cdot C_D = 2116\ psi$

$c := 0.8$ Constant for sawn lumber.

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

$F_{cE} := \frac{\pi^2 \, EI_{min}}{A \, (K \cdot l_1)^2} = 679 \ psi$ The equation for the Euler buckling stress given in NDS Section 3.7.1 is rearranged to show the term EI.

$$C_p := \frac{1 + \left(\frac{F_{cE}}{F_{c.star}}\right)}{2 \cdot c} - \sqrt{\left(\frac{1 + \left(\frac{F_{cE}}{F_{c.star}}\right)}{2 \cdot c}\right)^2 - \frac{\left(\frac{F_{cE}}{F_{c.star}}\right)}{c}} = 0.296$$

$F_c' := F_{c.star} \cdot C_p = 627 \ psi$

Combined Axial and Wind Loads on EStud:

$p := 30 \ psf$ Wind pressures on wall. For combined axial and bending checks, MWFRS wind loads may be used. For checking bending stresses independent of axial stresses, C&C wind loads shall be used.

$Spacing_{studs} := 16 \ in$

$S := \frac{d_2 \cdot d_1^2}{6} = 0.766 \ in^3$

$w := 0.75 \ p \cdot Spacing_{studs} = 30 \ plf$ A 0.75 factor is applied to the wind load in accordance with load combination 6a in Section 2.4.1 of ASCE 7-10.

$M_{mem} := \frac{w \cdot l_3^2}{12} = 382 \ lbf \cdot in$ For bending of the individual members of the EStud, the equation for a beam fixed at each end is used.

$f_b := \frac{M_{mem}}{S} = 499 \ psi$

$M_{stud} := \frac{w \cdot l_1^2}{8} = 2681 \ lbf \cdot in$ For bending of the entire EStud, the equation for a beam pinned at each end is used.

$f_{a\_bend} := \frac{M_{stud}}{\left(\frac{A}{2}\right) \cdot d_{eff}} = 272 \ psi$ Calculate the axial stress in each member of the EStud due to bending as the moment divided by the distance between members and the area of the member.

$P := 951 \ lbf$ Axial load on the Estud is selected to result in a CSI of 1.0.

$P_{c\_perp} := F_{c\_perp} \cdot C_b \cdot A = 2789\ lbf$ > $P = 951\ lbf$

$f_{a\_comp} := \frac{P}{A} = 181\ psi$

For positive wind pressures:

$f_c := f_{a\_bend} + f_{a\_comp} = 454\ psi$ < $F_{cE} = 679\ psi$ and < $F_c' = 627\ psi$ **OK**

$\left(\frac{f_c}{F_c'}\right)^2 + \frac{f_b}{F_b' \cdot \left(1 - \frac{f_c}{F_{cE}}\right)} = 1.00$ **OK**

$f_{c\_in} := f_{a\_comp} - f_{a\_bend} = -91\ psi$ < $F_t' = 1080\ psi$ **OK**

For negative wind pressures:

$f_t := f_{a\_comp} - f_{a\_bend} = -91\ psi$ < $F_t' = 1080\ psi$ **OK**

$\frac{f_t}{F_t'} + \frac{f_b}{F_b'} = 0.07$ < 1.00 **OK**

$f_c := f_{a\_comp} + f_{a\_bend} = 454\ psi$ < $F_{cE} = 679\ psi$ and < $F_c' = 627\ psi$ **OK**

Check Deflection Limit for EStud:

$\Delta := \frac{5 \cdot \left(\frac{w}{0.75}\right) \cdot l_1^4}{384 \cdot EI} = 0.38\ in$

Note that the wind load may be taken as 0.7 times the C&C load for the purpose of determining the stud deflection per IRC Table R301.7 and IBC Table 1604.3.

$\frac{l_1}{\Delta} = 244$ > 240 **OK** (for gypsum board wall finish)

Summary of Design Calculations for EStud:

The EStud has an axial load capacity of 951 lbs for an 8' tall wall with a wind pressure of 30 psf.