



## Evaluation Report CCMC 13319-R LP® SolidStart® LSL

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### 1. Opinion

It is the opinion of the Canadian Construction Materials Centre (CCMC) that “LP® SolidStart® LSL,” when used as structural composite lumber (SCL) in accordance with the conditions and limitations stated in Section 3 of this Report, complies with the National Building Code (NBC) of Canada 2015:

- Clause 1.2.1.1.(1)(a), Division A, using the following acceptable solutions from Division B:
  - Sentence 4.3.1.1.(1), Design Basis for Wood (CSA O86-14, “Engineering Design in Wood,” for SCL qualification)
- Clause 1.2.1.1.(1)(b), Division A, as an alternative solution that achieves at least the minimum level of performance required by Division B in the areas defined by the objectives and functional statements attributed to the following applicable acceptable solutions:
  - Article 9.23.2.2., Protection from Decay (“LP® SolidStart® LSL,” zinc borate treated LSL)
  - Sentence 9.23.4.2.(3), Spans for Joists, Rafters and Beams
  - Subsection 9.23.10., Wall Studs

This opinion is based on the CCMC evaluation of the technical evidence in Section 4 provided by the Report Holder.

Ruling No. 12-08-278 (13319-R) authorizing the use of this product in Ontario, subject to the terms and conditions contained in the Ruling, was made by the Minister of Municipal Affairs and Housing on 2012-06-21 (revised on 2017-02-22) pursuant to s.29 of the *Building Code Act*, 1992 (see Ruling for terms and conditions). This Ruling is subject to periodic revisions and updates.

### 2. Description

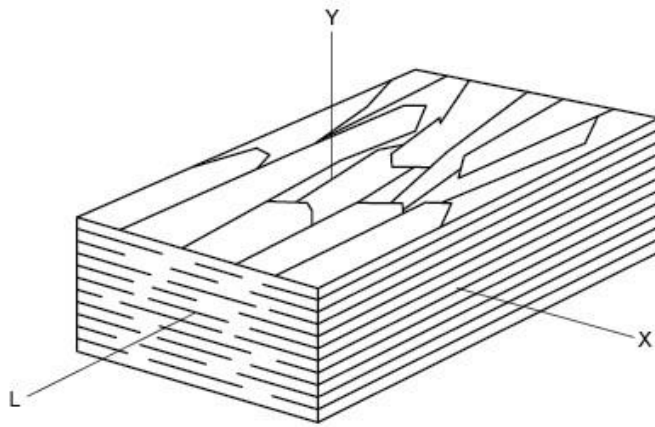
The product is a laminated strand lumber (LSL) that is used as a SCL and is manufactured from strands of wood blended with an isocyanate-based adhesive (CCMC 12009-R), oriented in a parallel direction, formed into mats, and pressed to the required thickness. The wood species, adhesive, manufacturing parameters, and finished product thickness, width, and length are as specified in the quality control manual that contains the manufacturing standard. See Figure 1 for strand orientation and details.

The product is available in thicknesses up to 88.9 mm, widths ranging from 111.1 mm to 457.2 mm, and lengths up to 19.5 m.

The manufacturing quality assurance program and records are verified by APA – The Engineered Wood Association as part of the product certification.

In addition, when the product is treated with zinc borate (ZB) it goes by the name of “LP® SolidGuard® LSL.” It may be installed within the building envelope (i.e., protected assemblies) when used as sill plates over masonry or concrete foundations, footings or slabs for decay fungi and termite resistance. The Use Category is UC2 as per AWPA, when interior construction is not in contact with the ground but may be subjected to dampness.

The permitted design values are outlined in Tables 4.1.1 to 4.1.4.



**Figure 1. Typical LSL profile showing orientations:**

**L direction – parallel to longitudinal direction of member**

**X direction – parallel to surface of member and normal to L direction**

**Y direction – normal to both L and X directions**

### 3. Conditions and Limitations

The CCMC compliance opinion in Section 1 is bound by the “LP® SolidStart® LSL” being used in accordance with the conditions and limitations set out below:

- The product, as with all SCL, is intended for dry service applications only.<sup>(1)</sup>
- The zinc borate treated product, “LP® SolidGuard® LSL,” follows Use Category 2 (UC2) as per AWP, when interior construction is not in contact with the ground but may be subjected to dampness. Unless noted within this Evaluation Report, all design provisions for the product apply to “LP SolidGuard LSL” as well.
- The product is intended for use in construction as an alternative material to lumber. Proprietary design values presented for the product are to be used by professional engineers for design in accordance with CSA O86, for structural applications such as beams, headers, joists, rafters, columns and studs as intended by the product manufacturer. The specific application must be qualified through testing and validated by the manufacturer. Applications such as I-joist flanges and metal-plated truss chords are beyond the scope of this Evaluation Report.
- See Appendix B for conditions and limitations for use of the product as studs in shear walls.

#### i. Manufacturer’s Pre-engineered Tables<sup>(2) (3)</sup>

The pre-engineered tables in the documents listed below have been provided to CCMC by the manufacturer to demonstrate compliance to Part 9, Housing and Small Buildings, of Division B of the NBC 2015, for acceptance by the local authority having jurisdiction (AHJ).

When the product is used as beams, headers and rim boards to support uniform loads only, the installation must be in accordance with the tables and installation details in the following documents published by Louisiana-Pacific Corp.:

1. *LP® SolidStart® LSL Beam and Header Technical Guide – Limit States Design*, April 2017;
2. *LP® SolidStart® OSB, LVL & LSL Rim Board – Limit States Design*, August 2014; and
3. *LP SolidStart LSL & LVL Wall Framing Technical Guide – Limit States Design*, April 2016.

The product must be installed in accordance with the manufacturer’s installation guidelines noted in these documents for those applications falling within the scope of the documents. Applications outside the scope of these installation guidelines require engineering on a case-by-case basis.

- (1) All lumber, wood-based panels and proprietary engineered wood products are intended for dry service conditions. “Dry service conditions” is defined as the in-service environment in which the average equilibrium moisture content (MC) of lumber is 15% or less over a year and does not exceed 19% at any time. Wood contained within the interior of dry, heated or unheated buildings has generally been found to have a MC between 6% and 14% depending on season and location. During construction, all wood-based products should be protected from the weather to ensure that the 19% MC is not exceeded in accordance with Article 9.3.2.5., Moisture Content, of Division B of the NBC 2015.
- (2) The pre-engineered tables present the pre-engineered factored resistance of the beam, wall stud or rim board. The AHJ may require further engineering to determine the factored load in accordance with Part 4 of Division B of the NBC 2015.
- (3) As per Section 9.4., Structural Requirements, of Division B of the NBC 2015, the adequacy of the rim board to transfer loads from shear walls

and the diaphragm must be verified, particularly in areas of high wind and high seismicity.

## ii. Manufacturer's Installation Details

The manufacturer's pre-engineered details within the documents listed in 3. (i) are limited in scope to building designs where the anticipated loads on the following structural details are not exceeded:

- headers supporting floor loads (page 5 of 1.);
- headers supporting roof loads (pages 8 and 9 of 1.);
- headers supporting floor and roof loads (pages 6 and 7 of 1.);
- beams supporting floor loads (pages 13 and 23 of 1.);
- beams supporting roof loads (pages 16-17 and 26-27 of 1.);
- beams supporting floor and roof loads (pages 14-15 and 24-25 of 1.);
- floor or roof uniform load tables (pages 10-11, 18-21 and 28-31 of 1.);
- bearing length details (pages 4, 12, and 22 of 1.);
- allowable holes (page 33 of 1.);
- support column details (page 33 of 1.);
- multiple member connections (page 34 of 1.);
- nail spacing (pages 34-35 of 1.);
- rim board details (pages 1-4 of 2.);
- interior column loads (page 5 of 3.);
- exterior wall stud loads (pages 6-7 of 3.); and
- exterior wall column loads (pages 8-15 of 3.).

## iii. Engineering Required

For structural applications beyond the scope/limitations of the above-referenced documents or when required by the AHJ, the drawings or related documents must bear the authorized seal of a professional engineer skilled in wood design and licensed to practice under the appropriate provincial or territorial legislation.

Installations beyond the scope/limitations of 3. (i) and 3. (ii) imply, but are not limited to, the following:

- higher loads/longer spans than the manufacturer's pre-engineered details;
- concentrated loads;
- areas of high wind or high seismicity;
- design of supporting members/columns when the total beam/header load exceeds the NBC 2015 pre-engineered beam/lintel tables; and
- design of supporting foundation footings when the total load exceeds the NBC 2015 pre-engineered floor/roof joist tables.

The engineer must design in accordance with CSA O86, and may use as a guide the *Engineering Guide for Wood-Frame Construction*, published by the Canadian Wood Council.

The specified strengths for the product must not exceed the values set forth in Tables 4.1.1 and 4.1.4. See Figure 1 for details about strand orientation. Basic nail, bolt and lag screw capacities must be as shown in Table 4.1.2. Nailing of the product must conform to Table 4.1.3. Stud and shear wall application and design details may be found in Table 4.1.5.

The ends of all product members used as joists, rafters and beams must be restrained to prevent rollover. This is normally achieved by attaching diaphragm sheathing either to the top or the compression edge and an end wall or shear transfer panel capable of transferring a minimum unfactored load of 730 N/m or required shear forces due to wind or seismic conditions. The compression edges of all beams must be continuously laterally supported at least every 610 mm, except when the design is done in accordance with CSA O86.

## iv. Engineering Support Provided by the Manufacturer

Louisiana-Pacific Corp. provides engineering support through distribution or a professional engineer skilled in wood design and licensed to practice under the appropriate provincial or territorial legislation. Louisiana-Pacific Corp. can also be consulted for technical support by telephone at 1-888-820-0325 or by email at [customer.support@lpcorp.com](mailto:customer.support@lpcorp.com).

- Damaged or defective products must not be used, unless repaired in accordance with written instructions from the manufacturer.
- This product must be identified with the phrase "CCMC 13319-R" along the side or top of the SCL member. This CCMC number is only valid when it appears in conjunction with the APA EWS certification mark.

## 4. Technical Evidence

The Report Holder has submitted technical documentation for the CCMC evaluation. Testing was conducted at laboratories recognized by CCMC. The corresponding technical evidence for this product is summarized below.

### 4.1 Design Requirements

**Table 4.1.1 Specified Strengths (MPa) of the Product<sup>(1) (2) (3) (4)</sup>**

Grade	Modulus of Elasticity <sup>(5)</sup> E MPa (× 10 <sup>6</sup> psi)	Beam Orientation (L-Y Plane)			Plank Orientation (L-X Plane)			Axial	
		Bending <sup>(6)</sup> F <sub>b</sub> MPa (psi)	Shear F <sub>v</sub> MPa (psi)	Compression Perpendicular to the Grain F <sub>cperp</sub> MPa (psi)	Bending F <sub>b</sub> MPa (psi)	Shear F <sub>v</sub> MPa (psi)	Compression Perpendicular to the Grain <sup>(7)</sup> F <sub>cperp</sub> MPa (psi)	Tension <sup>(8)</sup> F <sub>t</sub> MPa (psi)	Compression F <sub>cparallel</sub> MPa (psi)
<b>1730F<sub>b</sub> – 1.35E</b>	9 310 (1.35)	22.05 (3 195)	5.25 (760)	9.40 (1 365)	24.35 (3 530)	2.00 (290)	8.55 (1 240)	13.95 (2 020)	18.15 (2 635)
<b>2360F<sub>b</sub> – 1.55E</b>	10 690 (1.55)	30.05 (4 360)	5.25 (760)	11.00 (1 595)	33.40 (4 840)	2.00 (290)	9.69 (1 405)	18.70 (2 715)	23.90 (3 470)
<b>2500F<sub>b</sub> – 1.75E</b>	12 070 (1.75)	31.85 (4 620)	5.25 (760)	11.95 (1 730)	35.64 (5 170)	2.00 (290)	11.10 (1 610)	22.50 (3 260)	26.95 (3 910)

#### Notes to Table 4.1.1:

- (1) All values are in accordance with CSA O86.
- (2) Specified strengths are for standard term load duration and may be adjusted (with the exception of modulus of elasticity [MOE]) using load duration factors in accordance with CSA O86.
- (3) Specified bending stresses must apply to product installation conditions of use that are dry, well-ventilated interior applications in which the equivalent MC of lumber would not exceed 15%.
- (4) The specified strengths for “Beam” refer to loads applied parallel to the wide face of the strands (the edge of the member). “Plank” refers to loads applied perpendicular to the wide face of the strands (the face of the member). See Figure 2 for loading direction with respect to strand orientation.
- (5) The MOE is shear-free; therefore, when calculating deflection, both bending and shear deformations must be included. The following equation may be used for a simple supported loading condition under uniform load:

$$\Delta = \frac{5wL^4}{384EI} + \frac{2.4wL^2}{Ebd}$$

where:

Δ = deflection (mm)

w = specified uniform load (N/mm)

L = span (mm)

E = modulus of elasticity (shear-free) (MPa)

I = moment of inertia (mm<sup>4</sup>)

b = beam width (mm)

d = beam depth (mm)

- (6) The specified “Beam” bending strength, F<sub>b</sub>, is based on a standard depth of 305 mm. For other depths, multiply the values of F<sub>b</sub> by (305/d)<sup>0.120</sup> (where d is in mm). For depths less than 69 mm, multiply F<sub>b</sub> by 1.159.
- (7) The plank compression perpendicular to grain is based on the lesser of the average proportional limit stress and the average stress at the 1 mm (0.04 in.) deformation. In the calculation of the compressive resistance perpendicular to grain K<sub>Zcp</sub> must be 1.0 for the plank orientation (L-X).
- (8) The specified tension strength, F<sub>t</sub>, is assigned for a standard length of 6 096 mm (20 ft.). For other lengths, multiply F<sub>t</sub> by (6 096/L)<sup>0.092</sup> (where L is in mm). For lengths less than 914 mm, use the design tensile stresses adjusted to 914 mm.

**Table 4.1.2 Equivalent Specific Gravity for Fastener Design of the Product<sup>(1) (2)</sup>**

Grade	Equivalent Specific Gravity					
	Nails				Bolts and Lag Screws Installed in Face <sup>(3)</sup>	
	Withdrawal Load		Lateral Load		Lateral Load	
	Installed in Edge	Installed in Face	Installed in Edge	Installed in Face	Load Applied Parallel to Grain	Load Applied Perpendicular to Grain
<b>1730F<sub>b</sub> – 1.35E and above</b>	0.46	0.50	0.50	0.55	0.50	0.58

**Notes to Table 4.1.2:**

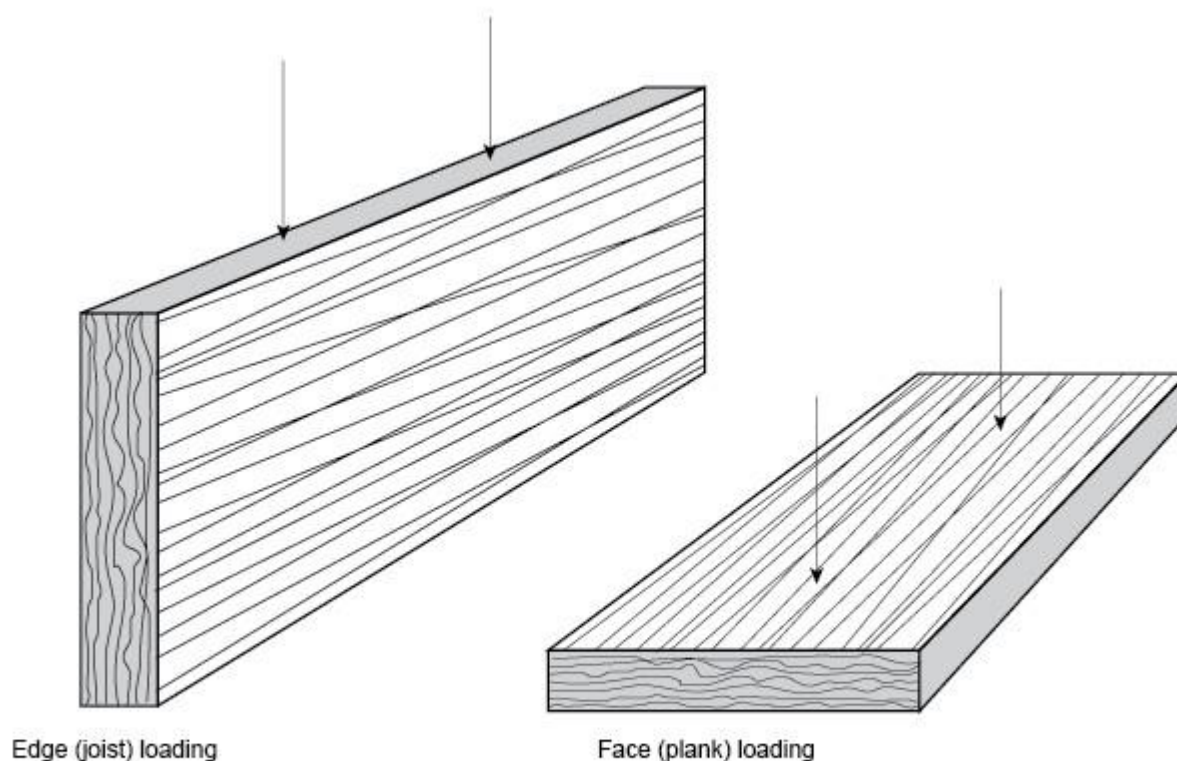
- (1) Fastener sizes and orientation not specifically described in this Table are beyond the scope of this Evaluation Report. See CSA O86, Table A10.1, for equivalent species based on relative density (specific gravity).
- (2) Fastener values based on the equivalent specific gravities in this Table are for standard term load duration and may be adjusted using load duration factors as per CSA O86.
- (3) The edge distance for bolts and lag screws when loaded parallel and perpendicular to the grain must be a minimum of four times the bolt diameter.

**Table 4.1.3 Nail Spacing of the Product<sup>(1)</sup>**

Nail Orientation	Thickness, mm (in.)	Fastener <sup>(2) (3)</sup>	Minimum End Distance, <sup>(4)</sup> mm (in.)	Closest O.C. Nail Spacing, <sup>(5)</sup> mm (in.)	
				Single Row	Multiple Rows <sup>(6) (7)</sup>
Edge	≥ 25 (≥ 1)	64 mm and smaller (8d and smaller)	51 (2)	102 (4)	Not permitted
		76 mm and 83 mm (10d and 12d)	51 (2)	102 (4)	
		89 mm (16d)	Not permitted <sup>(8)</sup>	Not permitted <sup>(8)</sup>	
	≥ 32 (≥ 1¼)	64 mm and smaller (8d and smaller)	51 (2)	102 (4)	Not permitted
		76 mm and 83 mm (10d and 12d)	51 (2)	102 (4)	
		89 mm (16d)	63 <sup>(9)</sup> (2½)	127 <sup>2</sup> (5)	
	≥ 38 (≥ 1½)	64 mm and smaller (8d and smaller)	51 (2)	76 (3)	76 (3)
		76 mm and 83 mm (10d and 12d)	51 (2)	76 (3)	102 (4)
		89 mm (16d)	63 <sup>2</sup> (2½)	102 (4)	152 (6)
	≥ 45 (≥ 1¾)	64 mm and smaller (8d and smaller)	51 (2)	76 (3)	76 (3)
		76 mm and 83 mm (10d and 12d)	51 (2)	76 (3)	102 (4)
		89 mm (16d)	63 <sup>(9)</sup> (2½)	76 (3)	152 (6)
Face <sup>(5)</sup>	All	64 mm and smaller (8d and smaller)	22 (7/8)	25 (1)	25 (1)
		76 mm and 83 mm (10d and 12d)	22 (7/8)	25 (1)	25 (1)
		89 mm (16d)	22 (7/8)	38 (1½)	38 (1½)

### Notes to Table 4.1.3:

- (1) Fastener sizes and closest on centre (o.c.) nail spacing not specifically described in this Table are beyond the scope of this Report.
- (2) Fasteners are common wire or common spiral nails.
- (3) Nail penetration for edge nailing must not exceed 51 mm (2 in.) for 89-mm (16d 3½ in.) nails and 64 mm (2½ in.) for 76-mm (10d 3 in.) and 83-mm (12d 3¼ in.) nails.
- (4) Edge distance must be sufficient to prevent splitting, but not less than permitted in CSA O86.
- (5) The tabulated closest o.c. spacing for the face orientation is applicable to nails that are installed in rows that are parallel to the direction of the grain (length) of the LSL. For nails in face installed in rows that are perpendicular to the direction of the grain (width/depth) of the LSL, the closest o.c. spacing for the face orientation must be as per CSA O86.
- (6) For multiple rows of nails, the rows must be offset 13 mm (½ in.) or more from each other and staggered.
- (7) For multiple rows of nails, rows must be equally spaced from the centre line of the product's edge or face (whichever applies).
- (8) Minimum end distance may be reduced to 64 mm (2½ in.) and closest o.c. nail spacing may be reduced to 127 mm (5 in.) when the LSL is 28 mm (1½ in.) or thicker.
- (9) Minimum end distance may be reduced to 51 mm (2 in.) and closest o.c. nail spacing may be reduced to 102 mm (4 in.) when the LSL is 32 mm (1¼ in.) or thicker and the nail penetration into the LSL does not exceed 35 mm (1⅜ in.).



Note : Edge/joist loading is parallel to WFS  
Face/plank loading is perpendicular to WFS

**Figure 2. Load direction with respect to wide face strand (WFS) orientation**



**Table 4.1.4 Factored Resistances for “LP® SolidStart® LSL” Rim Board<sup>(1) (2) (3)</sup>**

Grade	Thickness, mm (in.)	Depth, mm (in.)	Vertical Load Resistance		Horizontal Load Transfer Resistance <sup>(3) (4)</sup> $\phi H$ kN/m (lb/ft.)	Lateral Resistance of 13 mm (½ in.) Lag Screw <sup>(5)</sup> $\phi Z$ kN (lb)
			Uniform $\phi V$ kN/m (lb/ft.)	Concentrated $\phi P$ kN (lb)		
<b>1.35E and better</b>	29 <sup>(6)</sup> (1 ⅞)	≤ 406 (≤ 16)	118 (8 090)	26.0 (5 838)	3.81 (261)	2.97 (667)
	≥ 32 (≥ 1 ¼)	≤ 406 (≤ 16)	146 (10 008)	28.2 (6 338)	4.76 (326)	3.34 (751)
		≤ 610 (≤ 24)	92.5 (6 338)			
	≥ 38 (≥ 1 ½)	≤ 406 (≤ 16)	170 (11 676)	33.4 (7 506)	5.33 (365)	3.52 (792)
		≤ 610 (≤ 24)	110 (7 506)			

**Notes to Table 4.1.4:**

- (1) The factored resistances are for the rim board only, under standard term and dry service loading; therefore, adjustment is permitted for other load durations in accordance with CAN/CSA-O86-14, “Engineering Design in Wood.” The compressive resistance of the sill plate also must be checked in accordance with CAN/CSA-O86-14.
- (2) See Table 4.1.3 for minimum nail spacing requirements.
- (3) The horizontal (lateral) load transfer resistance is for shear forces parallel to the rim joist under short-term loading and dry service conditions only. The fastening of the floor must meet or exceed Part 9 of the NBC 2015.
- (4) The nailing schedule for sheathing to rim is based on 51 mm (6d 2 in.) nails at 150 mm (6 in.) o.c., and rim board to sill plate (toe nailed) is based on 64-mm (8d 2½ in.) nails at 150 mm (6 in.) o.c. Values assume floor joists or blocking fastened to the rim board and sill plate at 610 mm (24 in.) o.c. maximum as per Part 9 of the NBC 2015. Commercial framing connectors may be used to achieve lateral load capacities exceeding the values in this Table. Calculations must be based on the equivalent specific gravity listed in Table 4.1.2 and must not exceed the nail spacing requirements of Table 4.1.3.
- (5) Lag screw lateral resistance values are based on a 38-mm-thick (1½ in.) side member with full penetration of the lag screw.
- (6) The 29-mm-thick (1⅞ in.) “LP® SolidStart® LSL” rim board meets the requirements of ANSI/APA PRR 410-2011 Rim Board Grade B2 as specified in CCMC 13308-L.

**Table 4.1.5 Stud and Shear Wall Applications of the Product<sup>(1) (2)</sup>**

Grade	Nailing <sup>(3) (4)</sup>	Species Factor for Framing Material ( $J_{sp}$ )
<b>1.35E LSL</b>	Panel edge nailing of 75 mm to 150 mm <sup>(5)</sup> Centre nailing of 300 mm	0.9
<b>1.55E LSL</b>		
<b>1.75E LSL</b>		

**Notes to Table 4.1.5:**

- (1) The product may be used as wall stud material in accordance with the prescriptive requirements of Part 9 of the NBC 2015. The specified shear strength for nailed structural panel shear walls utilizing the product framing are equivalent to lumber and must be determined in accordance with Table 9.5.1A of CSA O86 for the specified nail spacing in Table 4.1.5 and species factor (See CSA O86-09 extract in Appendix C of this Report).
- (2) See Appendix B for conditions and limitations on stud and shear wall applications.
- (3) See Appendix B, Note 12.
- (4) For unblocked walls, the nails must not exceed D = 3.3 mm (0.131 in.) (8d) and 64 mm (2.5 in.) nor placed closer than 150 mm (6 in.) o.c. For blocked walls, the nails must not exceed D = 3.7 mm (0.148 in.) (10d) and 76 mm (3 in.) nor be placed closer than 75 mm (3 in.) o.c.
- (5) 63.5-mm nails, 100 mm o.c. perimeter nailing, single centre stud; 75-mm nails, 150 mm o.c. perimeter nailing, single centre stud; 75-mm nails, 75 mm o.c. perimeter nailing (staggered 6 mm), double centre stud.

The manufacturing quality assurance program has been updated to include requirements specified in ASTM D 5456-07, “Standard Specification for Evaluation of Structural Composite Lumber Products,” and has been verified by independent, third-party monitoring and inspection conducted by APA EWS as part of the product certification.

## Report Holder

Louisiana-Pacific Corporation  
414 Union Street, Suite 2000  
Nashville, TN 37219  
USA

**Telephone:** 615-986-5600

**Fax:** 615-986-5666

## Plant(s)

Houlton, ME, USA

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**Date modified:**  
2019-09-24



## Appendix A

The design values obtained from testing to ASTM D 5456-01 and ASTM D 5456-07 as specified in CAN/CSA-O86-01 and CSA O86-09 are summarized below.

**Table A1 Additional Test Information for the Product**

Property	Test Information
<b>Bending</b>	Specimens were tested in edgewise and flatwise bending to establish the characteristic value. Qualification test data have been used to establish the applicable coefficient of variation, $CV_w$ , and the reliability normalization factor from CAN/CSA-O86-01 was used to determine the specified strength.
<b>Shear</b>	Specimens were tested in shear to establish the characteristic value. Qualification test data have been used to establish the applicable coefficient of variation, $CV_w$ , and the reliability normalization factor from CAN/CSA-O86-01 was used to determine the specified strength.
<b>Compression parallel to the grain</b>	Specimens were tested in compression parallel to the grain to establish the characteristic value. Qualification test data have been used to establish the applicable coefficient of variation, $CV_w$ , and the reliability normalization factor from CAN/CSA-O86-01 was used to determine the specified strength.
<b>Compression perpendicular to the grain</b>	Specimens of 1.35E were tested in compression perpendicular to the grain in plank orientation, in accordance with ASTM D 5456-14b, the lesser of Article 6.5.4. (proportional limit) and Article 7.4.3.2. (1 mm (0.04 in.)) to determine the characteristic value, and multiplied by 1.81 as per CSA O86-14, Clause 16.3.3.5. For the joist orientation, the characteristic value (1 mm (0.04 in.)) deformation) was multiplied by 1.09 to establish the specified strength in accordance with CAN/CSA-O86-01.
<b>Tension parallel to the grain</b>	Specimens were tested in tension to establish the characteristic value. Qualification test data have been used to establish the applicable coefficient of variation, $CV_w$ , and the reliability normalization factor from CAN/CSA-O86-01 was used to determine the specified strength.
<b>Nail withdrawal</b>	Nail withdrawal values were established following ASTM D 1761-12, “Standard Test Methods for Mechanical Fasteners in Wood,” for an 8d common nail having a 31.75-mm penetration. Specimens were tested and the equivalent species capacity was determined in accordance with ASTM D 5456-98, A2.4.
<b>Nail bearing</b>	Dowel bearing strength was determined as per ASTM D 5764-95, “Standard Test Method for Evaluating Dowel Bearing Strength of Wood and Wood-Based Products,” with 10d common nails with a nominal diameter of 3.76 mm and a lead hole diameter of 2.77 mm. Specimens were tested and the mean bearing capacity was used to establish the equivalent species capacity as per ASTM D 5456-98, A2.5.
<b>Bolt bearing</b>	Bolt bearing capacity was determined in accordance with ASTM D 5764-95 with 12.5-mm and 19-mm bolts. Specimens were tested and the mean bolt bearing capacity was used to establish the equivalent species capacity as per ASTM D 5456-98, A2.5.
<b>Creep</b>	A total of 53 specimens were tested and a 90-day creep assessment was conducted in accordance with ASTM D 5456-98 and ASTM D 6815-02a, “Standard Specification for Evaluation of Duration of Load and Creep Effects of Wood and Wood-Based Products.” It demonstrated equivalency to the duration of load behaviour of sawn lumber.
<b>Adhesives</b>	The binder meets CSA O437.2-93, “Evaluation of Binder Systems for OSB and Waferboard,” with modifications. In addition, after a 14-day soak conditioning, the LSL specimens with an equivalent methylene diphenyl diisocyanate (MDI) binder were subjected to the 90-day creep test of ASTM D 6815 and performance equivalent to lumber was demonstrated.
<b>Zinc borate treatment</b>	The product was treated with zinc borate in accordance with AWWA N2-03, “Standard for the Preservative Treatment of Composite Wood Products by Nonpressure Processes.” It was found to be effective in controlling decay for environmental conditions expected in sill plate applications. In addition, the ZB treatment was found not to affect the structural and fastener properties based on a test program.
<b>Stud and Shear Wall Qualification</b>	
<b>Stud (general)</b>	<b>Notching:</b> All three grades of the product were notched 20% and 40% of the cross section and tested in tension, bending and compression. All grades showed higher residual strength than unnotched 2 × 6 Douglas fir sawn lumber (not NBC specified minimum stud lumber).
	<b>End nail connection:</b> Lateral nail capacity of 10 stud/plate connections were tested with 4 mm to 82 mm (16d) nails and a minimum 5.3 kN was attained, which exceeds the 3.77 kN criterion.
	<b>Nail slip, <math>e_n</math>, performance (optional):</b> Not applicable.
<b>Studs in shear walls</b>	Full-scale shear wall tests of the three LSL grades, 12 mm (25/32 in.) sheathing thickness, nail size and spacing were undertaken to verify equivalency to lumber shear walls in Table 9.5.1A in CSA O86-09. Testing was performed following the CUREE Method C in ASTM E 2126. Three parameters needed to be met based on the equivalent energy elastic-plastic (EEEP) curve. The three parameters included: (i) ductility ( $\mu$ ) $\geq 11$ ; (ii) drift capacity ( $D_u$ ) $\geq 0.028H$ ; and (iii) $2.3 \leq \text{overstrength } (\Omega) \leq 5.0$ . These criteria were met for the LSL grades, panel edge spacing and species adjustment outlined in Table 4.1.5.

## Appendix B

### B1. Conditions and Limitations for Stud and Shear Wall Applications

#### B1.1 For use in Part 9 applications:

1. For general stud applications, notwithstanding that Article 9.23.5.3. of the NBC 2015 permits notching of stud grade lumber up to one-third of the depth, “LP® SolidStart® LSL” studs must not be notched more than 25% of the stud depth.
2. Braced wall panels utilizing LSL studs are subject to the limitations in Article 9.23.1.1. of the NBC 2015 as applicable.
3. Fasteners for sheathing must conform to Tables 9.23.3.5.A. and 9.23.3.5.B. of the NBC 2015.
4. Appropriate LSL grades must be specified for stud size and spacing must conform to Table 9.23.10.1. of the NBC 2015.
5. LSL stud-braced walls must be detailed in accordance with Subsection 9.23.13., Bracing to Resist Lateral Loads Due to Wind and Earthquake, of the NBC 2015.

#### B1.2 For use in Part 4 applications:

1. Blocked shear walls with LSL studs can be used as lateral load resisting systems in wood construction in Canada with no height limitation. Unblocked shear walls are limited to a height of 4.9 m (16 ft.) as per Section 11.4.3 of CSA O86-14.
2. When a vertical load is present on any wall, it should be included in the design of the wall studs, especially in the case of high walls to avoid potential stud buckling.
3. Blocked shear walls must be used in high seismic zones (i.e., Part 4, where  $I_E F_a S_a(0.2) \geq 0.35$ , and Part 9, where  $S_a(0.2) \geq 0.7$  in the NBC 2015).
4. Double-sided walls with LSL studs should be a minimum nominal 2 in.  $\times$  6 in. for connections with 76-mm (10d) nails and a spacing of 76 mm. Nail spacing of 100 mm or more is not expected to produce significant splitting of the LSL studs. Alternatively, nails must be attached in accordance with Table 9.5.1A, Note 3 of CSA O86-09.
5. In cases where double studs are used in walls with laminated veneer lumber (LVL)/LSL studs, the connection between plies must be designed with mechanical fasteners to resist the shear force at the stud interface and prevent separation of the studs. Relatively large forces are generated between the studs during the shear wall response, especially in the end studs and at studs on the perimeters of the panels.
6. The nail diameter for sheathing to framing connections in any wall must not exceed 3.7 mm.
7. The nail spacing in any case must be equal to or greater than the minimum nail spacing of 76 mm.
8. The size of the nail heads should be equal to or larger than those of the nails used in the testing program (63.5 mm (8d) nail, 3.3 d/64 L/7.1 mm head, 76 mm (10d) nail, 3.7 mm d/76 mm L/8 mm head).
9. Maximum sheathing thickness of 15.8 mm (5/8 in.) can be used in combination with the same length of nails and nail spacing as used in the testing. Sheathing thickness beyond 15.8 mm (5/8 in.) is not permitted.
10. See Table 4.1.5., Note 5.
11. The stud spacing must not exceed 610 mm (2 ft.) o.c.
12. The 64-mm-stud (or double 38-mm-stud) requirements outlined in Table 9.5.1A of CSA O86-09 must be applied. The double wall studs should be constructed by joining single studs by a sufficient number of either nails or screws. The connection between plies must be designed with mechanical fasteners to resist the shear force at the stud interface and prevent separation of the studs.

## Appendix C

### C1. Extract of CSA O86-09 Douglas Fir-Larch Framing Shear Wall Table 9.5.1A and Species Factor for Framing, Table 9.4.3.

Table 9.5.1A  
Specified Shear Strength,  $v_d$ , for Shearwalls with  
Framing of Douglas Fir-Larch (kN/m)

Minimum nominal panel thickness, mm	Minimum nail penetration in framing, mm	Common nail diameter, mm	Panel applied directly to framing			
			Nail spacing at panel edges, mm			
			150	100	75	50†
7.5§	31	2.84	4.9	7.3	9.5	12.2
9.5	31	2.84	5.4	8.2	10.6	13.9
9.5	38	3.25	6.0*	8.7*	11.1*	14.4*
11.0	38	3.25	6.5*	9.5*	12.2*	15.9*
12.5	38	3.25	7.1	10.3	13.3	17.4
12.5	41	3.66‡	8.4	12.5	16.3	20.9
15.5	41	3.66‡	9.2	13.9	18.1	23.7

\*The values for 9.5 mm and 11.0 mm panels applied directly to framing may be increased to values shown, respectively, for 11.0 mm and 12.5 mm panels, provided studs are spaced at a maximum of 400 mm on centre.

†Framing at adjoining panel edges shall be 64 mm lumber (or two 38 mm wide framing members connected to transfer the factored shear force) or wider, and nails shall be staggered where nails are spaced 50 mm on centre.

‡Framing at adjoining panel edges shall be 64 mm lumber (or two 38 mm width framing members connected to transfer the factored shear force), or wider and nails shall be staggered where nails of 3.66 mm diameter having penetration into framing of more than 41 mm are spaced 75 mm or less on centre.

§9.5 mm minimum recommended when applied directly to framing as exterior siding.

#### Notes:

- 1) Tabulated values are applicable to nailed shear panels using structural wood-based panels based on dry service conditions and standard duration of load.
- 2) All panel edges are backed with 38 mm or wider framing. Panels are installed either horizontally or vertically, with nails spaced at 300 mm on centre along intermediate framing members. For unblocked horizontal panels, see [Clause 9.4.4](#).
- 3) Where panels are applied on both faces of a wall and nail spacing is less than 150 mm on centre on either side, panel joints shall be offset to fall on different framing members or framing shall be 64 mm or thicker and nails on each side shall be staggered.
- 4) For panels applied over 12.7 mm or 15.9 mm gypsum wallboard, specified shear strength for the same thickness panel applied directly to framing may be used as long as minimum nail penetration (in the framing) is satisfied.
- 5) For shearwalls fabricated with nails having a diameter that deviates from those presented in the table (e.g., power-driven nails), consult [Clause A9.5.1](#) for an appropriate modification factor, which should be applied to the capacities given in the table.
- 6) For construction sheathing OSB, product specification shall also include a panel mark identifying an end-use rating. [Table 9.5.3](#) provides an equivalence between tabulated thicknesses and panel marks.

### 9.4.3 Species Factor for Framing Material, $J_{sp}$

The specified shear strengths for wood-based shearwalls and diaphragms shall be multiplied by the species factor for framing material,  $J_{sp}$ , as given in Table 9.4.3.

Table 9.4.3  
Species Factor for Framing Material,  $J_{sp}$

$J_{sp}$	Visually graded lumber	Glued-laminated timber	MSR (or MEL) E-Grade of S-P-F,* MPa
1.0	Douglas Fir-Larch	Douglas Fir-Larch	13 800 to 16 500
0.9	Hem-Fir	N/A	12 400 to 13 100
0.8	S-P-F	Spruce-Pine	8300 to 11 700
0.7	Northern Species	N/A	N/A

*\*For other species of MSR or MEL lumber, use visually graded lumber values.*