

Joint Evaluation Report

ESR-3631

Reissued September 2019

This report is subject to renewal September 2020.

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A Subsidiary of the International Code Council®

DIVISION: 06 00 00—WOOD, PLASTICS AND COMPOSITES

Section: 06 17 19—Cross-laminated Timber

REPORT HOLDER:

STRUCTURLAM MASS TIMBER CORPORATION

EVALUATION SUBJECT:

STRUCTURLAM CROSSLAM® CLT

1.0 EVALUATION SCOPE

1.1 Compliance with the following codes:

- 2018, 2015, 2012, and 2009 *International Building Code*® (IBC)
- 2018, 2015, 2012, and 2009 *International Residential Code*® (IRC)

For evaluation for compliance with codes adopted by the Los Angeles Department of Building and Safety (LADBS), see [ESR-3631 LABC and LARC supplement](#).

Property evaluated:

Structural

1.2 Evaluation to the following green code(s) and/or standards:

- 2016 California Green Building Standards Code (CALGreen), Title 24, Part 11
- 2015, 2012 and 2008 ICC 700 *National Green Building Standard*™ (ICC 700-2015, ICC 700-2012 and ICC 700-2008)

Attributes verified:

See Section 3.1

2.0 USES

Structurlam CrossLam® CLT is a cross-laminated timber (CLT) panel for use as components in floors and roofs in Type I and II Construction (IBC) and in roof and floor decks in Type III (interior floor decks only), IV and V construction (IBC). When panels are installed under the IRC, an engineered design is required in accordance with IRC Section R301.1.3.

3.0 DESCRIPTION

3.1 General:

The Structurlam CrossLam® CLT panels described in this evaluation report comply with requirements noted in Section 2303.1.4 of the 2018 and 2015 IBC, for allowable stress design in accordance with IBC Section 2301.2(1)

and consist of three to nine layers of nominally 2x sawn lumber boards (laminations) stacked with wood grain orientation alternating 90 degrees at each layer. The Structurlam CrossLam® CLT panels are manufactured by face-bonding each layer using a non-formaldehyde-based, exterior-type structural adhesive, and then are placed in a press to form a dimensionally stable structural element, or plank billet. The Structurlam CrossLam® CLT panels are available in plank billets with gross thickness of 3.43 inches (87 mm) to 12.42 inches (315 mm), nominal widths of 12 inches (305 mm) to 120 inches (3050 mm), and lengths up to 40 feet (12 190 mm). Refer to Table 1 for the grade and layup designations of Structurlam CrossLam® CLT panels. Figure 2 depicts typical 3-ply and 5-ply layups of Structurlam CrossLam® CLT panels.

The attributes of the Structurlam CrossLam® CLT have been verified as conforming to the provisions of (i) CALGreen Sections A4.404.3 for efficient framing techniques; (ii) ICC 700-2015 and ICC 700-2012 Section 608.1(2), 11.608.1(2) and 12(A).608.1 for resource-efficient materials; and (iii) ICC 700-2008 Section 607.1(2) for resource-efficient materials. Note that decisions on compliance for those areas rest with the user of this report. The user is advised of the project-specific provisions that may be contingent upon meeting specific conditions, and the verification of those conditions is outside the scope of this report. These codes or standards often provide supplemental information as guidance.

3.2 Material:

3.2.1 Wood Laminations: Wood laminations used in manufacturing Structurlam CrossLam® CLT panels must be in accordance with the approved in-plant manufacturing standard using spruce-pine fir (SPF) sawn lumber having a minimum specific gravity of 0.42 and reference design values provided in Table 4A of the *National Design Specification*® (NDS) for Wood Construction. The outermost SPF laminations shall be permitted to be replaced by Douglas fir-Larch lumber with design properties that are equal to or greater than the corresponding SPF laminations.

3.2.2 Adhesives: Adhesive used to face-bond layers of Structurlam CrossLam® CLT panels is non-formaldehyde based, exterior-type structural adhesive and adhesive used for finger-joints of wood laminations is two-component melamine urea, conforming to product specifications in the approved quality documentation

4.0 DESIGN AND INSTALLATION

4.1 General:

Design and installation of Structurlam CrossLam® CLT panels described in this evaluation report must be in accordance with this evaluation report, the applicable code

provisions and the manufacturer's published design and/or installation instructions. The manufacturer's design and/or installation instructions must be available at the jobsite at all times during installation. The requirements specified for allowable stress design in accordance with IBC Section 2301.2(1), and Chapter 10 of the 2018 or 2015 NDS, are applicable to Structurlam CrossLam® CLT panels.

4.2 Reference Design Values:

Tables 2 and 3 provide, respectively, reference design values for bending capacities and in-plane shear capacities of Structurlam CrossLam® CLT panels. The reference design values in Tables 2 and 3 are intended for allowable stress design and must be adjusted in accordance with Section 4.3 of this evaluation report.

4.3 Adjustment Factors:

The reference design values in Tables 2 and 3 must be adjusted using the adjustment factors specified in Table 10.3.1 of the 2018 or 2015 NDS. The reference design values in Table 2 must not be increased for the lumber size adjustment factor in accordance with NDS. The time dependent deformation (creep) factor, K_{cr} , of 2.0, as specified in Section 3.5.2 of the NDS must be used to calculate the total deflection due to long-term loading for Structurlam CrossLam® CLT panels used as components in floor and roof decks under dry service condition where the moisture content in lumber in service is less than 16 percent, as in most covered structures.

4.4 Fire Resistance:

When fire resistance is required, the fire resistance for the exposed Structurlam CrossLam® CLT panels must be determined by calculation in accordance with Chapter 16 of the 2018 or 2015 NDS.

5.0 CONDITIONS OF USE

The Structurlam CrossLam® CLT described in this report complies with, or is a suitable alternative to what is specified in, those codes listed in Section 1.0 of this report, subject to the following conditions:

- 5.1 Fabrication, design, and installation must comply with this evaluation report and the manufacturer's published design/installation instructions. In the event of a conflict between the manufacturer's published design/installation instructions and this evaluation report, the most restrictive one governs.
- 5.2 Use of Structurlam CrossLam® CLT panels must be limited to dry service conditions where the moisture content in lumber in service is less than 16 percent, as in most covered structures.
- 5.3 Calculations and drawings demonstrating compliance with this evaluation report must be submitted to the code official. The calculations and drawings must be prepared by a registered design professional where required by the statutes of the jurisdiction in which the project is to be constructed.
- 5.4 Connectors and connections for Structurlam CrossLam® CLT panels used as components in floor and roof decks have not been evaluated and are out of the scope of this evaluation report.

5.5 Cutting, drilling, and notching of Structurlam CrossLam® CLT panels when used as components in floor and roof decks have not been evaluated and are out of the scope of this evaluation report.

5.6 Structurlam CrossLam® CLT panels used as components in roof and floor decks have not been evaluated for diaphragm design and the diaphragm design is out of the scope of the evaluation report.

5.7 To be considered as part of a floor and roof diaphragm, CLT panels used to resist in-plane shear forces in floor and roof diaphragms shall be accompanied by complete detailing and diaphragm design to the satisfaction of the code official.

5.8 Structurlam CrossLam® CLT panel roof decks shall be covered with approved roof coverings secured to the building or structure in accordance with applicable provisions of IBC Chapter 15.

5.9 The special inspection shall be conducted in accordance with the applicable requirements of Sections 1704 and 1705 of the IBC.

5.10 Structurlam CrossLam® CLT panels used as components in floor and roof decks under the IRC when engineered design is submitted in accordance with Section R301.1.3. Structurlam CrossLam® CLT panels are fabricated in Okanagan Falls, British Columbia, Canada, under a quality-control program with inspections by ICC-ES and APA—The Engineered Wood Association.

6.0 EVIDENCE SUBMITTED

Data in accordance with the ICC-ES Acceptance Criteria for Cross-laminated Timber Panels for Use as Components in Floor and Roof Decks (AC455), dated May 2018.

7.0 IDENTIFICATION

7.1 Structurlam CrossLam® CLT panels are identified with stamps noting the Structurlam Mass Timber Corporation name or logo (Figure 1), plant number, product layout and designation, production date and shift, and ICC-ES evaluation report number (ESR-3631).

7.2 The report holder's contact information is the following:

STRUCTURLAM MASS TIMBER CORPORATION
2176 GOVERNMENT STREET
PENTICTON, BRITISH COLUMBIA V2A 8B5
CANADA
(250) 492-8912
www.structurlam.com

TABLE 1—STRUCTURLAM CROSSLAM® CLT PANEL LAYUPS

CLT LAYUP ¹	CLT PANEL THICKNESS DESIGNATION	CLT THICKNESS t_p^2 (in.)	LAMINATION ACTUAL THICKNESS ³ (in.)								
				⊥		⊥		⊥		⊥	
V2.1	87V	3.43	1.38	0.67	1.38	-	-	-	-	-	-
	139V	5.47	1.38	0.67	1.38	0.67	1.38	-	-	-	-
	191V	7.52	1.38	0.67	1.38	0.67	1.38	0.67	1.38	-	-
	243V	9.57	1.38	0.67	1.38	0.67	1.38	0.67	1.38	0.67	1.38
V2M1	99V	3.90	1.26	1.38	1.26	-	-	-	-	-	-
	169V	6.66	1.26	1.38	1.38	1.38	1.26	-	-	-	-
	239V	9.42	1.26	1.38	1.38	1.38	1.38	1.38	1.26	-	-
	309V	12.18	1.26	1.38	1.38	1.38	1.38	1.38	1.38	1.38	1.26
V2M1.1	105V	4.14	1.38	1.38	1.38	-	-	-	-	-	-
	175V	6.90	1.38	1.38	1.38	1.38	1.38	-	-	-	-
	245V	9.66	1.38	1.38	1.38	1.38	1.38	1.38	1.38	-	-
	315V	12.42	1.38	1.38	1.38	1.38	1.38	1.38	1.38	1.38	1.38
V2M2	169V XL	6.66	1.26 + 1.38	1.38	1.38 + 1.26	-	-	-	-	-	-
	239V XL	9.42	1.26 + 1.38	1.38	1.38	1.38	1.38 + 1.26	-	-	-	-
	309V XL	12.18	1.26 + 1.38	1.38	1.38	1.38	1.38	1.38	1.38 + 1.26	-	-
V2M2.1	175V XL	6.90	1.38 + 1.38	1.38	1.38 + 1.38	-	-	-	-	-	-
	245V XL	9.66	1.38 + 1.38	1.38	1.38	1.38	1.38 + 1.38	-	-	-	-
	315V XL	12.42	1.38 + 1.38	1.38	1.38	1.38	1.38	1.38	1.38 + 1.38	-	-
V2.1M1	157V XL	6.19	1.38 + 1.38	0.67	1.38 + 1.38	-	-	-	-	-	-
	209V XL	8.24	1.38 + 1.38	0.67	1.38	0.67	1.38 + 1.38	-	-	-	-
	261V XL	10.29	1.38 + 1.38	0.67	1.38	0.67	1.38	0.67	1.38 + 1.38	-	-
E1M4	87E	3.43	1.38	0.67	1.38	-	-	-	-	-	-
	139E	5.47	1.38	0.67	1.38	0.67	1.38	-	-	-	-
	191E	7.52	1.38	0.67	1.38	0.67	1.38	0.67	1.38	-	-
	243E	9.57	1.38	0.67	1.38	0.67	1.38	0.67	1.38	0.67	1.38
E1M5	105E	4.14	1.38	1.38	1.38	-	-	-	-	-	-
	175E	6.90	1.38	1.38	1.38	1.38	1.38	-	-	-	-
	245E	9.66	1.38	1.38	1.38	1.38	1.38	1.38	1.38	-	-
	315E	12.42	1.38	1.38	1.38	1.38	1.38	1.38	1.38	1.38	1.38
E1M6	157E XL	6.19	1.38 + 1.38	0.67	1.38 + 1.3.8	-	-	-	-	-	-
	209E XL	8.24	1.38 + 1.38	0.67	1.38	0.67	1.38 + 1.38	-	-	-	-
	261E XL	10.29	1.38 + 1.38	0.67	1.38	0.67	1.38	0.67	1.38 + 1.38	-	-
E1M7	175E XL	6.90	1.38 + 1.38	1.38	1.38 + 1.38	-	-	-	-	-	-
	245E XL	9.66	1.38 + 1.38	1.38	1.38	1.38	1.38 + 1.38	-	-	-	-
	315E XL	12.42	1.38 + 1.38	1.38	1.38	1.38	1.38	1.38	1.38 + 1.38	-	-

For SI: 1 in. = 25.4 mm.

¹The CLT layups are developed based on the 2017 ANSI/APA PRG 320, using visually graded sawn lumber noted in Section 3.2.1 of the evaluation report. CLT layups ending with XL in CLT panel thickness designation are manufactured with two laminations with wood grain orientation running in the same direction at the outmost surfaces of the CLT panels.

²Gross thickness of CLT panels.

³Actual thickness of lamination after planning. "||": Face laminations are oriented parallel to the major strength direction and "⊥": Face laminations are oriented perpendicular to the major strength direction.

TABLE 2—REFERENCE DESIGN VALUES FOR STRUCTURLAM CROSSLAM® CLT PANELS¹

CLT LAYUP ²	CLT PANEL THICKNESS DESIGNATION	MAJOR STRENGTH DIRECTION				MINOR STRENGTH DIRECTION			
		(F _b S) _{eff.,i,0} (lb _f -ft/ft)	(EI) _{eff.,i,0} (x10 ⁶ lb _f -in. ² /ft)	(GA) _{eff.,i,0} (x10 ⁶ lb _f /ft)	V _{s,0} (lb _f /ft)	(F _b S) _{eff.,i,90} (lb _f -ft/ft)	(EI) _{eff.,i,90} (x10 ⁶ lb _f -in. ² /ft)	(GA) _{eff.,i,90} (x10 ⁶ lb _f /ft)	V _{s,90} (lb _f /ft)
V2.1	87V	1,440	56	0.48	1,230	35	0.36	0.30	240
	139V	3,325	206	0.96	1,970	540	21	0.60	980
	191V	5,925	503	1.4	2,700	1,220	84	0.91	1,710
	243V	9,200	995	1.9	3,450	2,140	210	1.2	2,450
V2M1	99 V	1,800	79	0.49	1,400	280	3.7	0.52	495
	169 V	4,275	321	1.0	2,400	2,410	96	1.0	1,490
	239 V	7,700	818	1.5	3,400	5,550	367	1.6	2,480
	309 V	12,075	1,662	2.1	4,375	9,800	910	2.1	3,475
V2M1.1	105V	2,050	96	0.53	1,490	280	3.7	0.53	495
	175V	4,725	367	1.1	2,480	2,410	96	1.1	1,490
	245V	8,350	910	1.6	3,475	5,500	367	1.6	2,480
	315V	12,925	1,814	2.1	4,475	9,800	910	2.1	3,475
V2M2	169 V XL	5,450	409	1.0	2,400	275	3.7	0.61	495
	239 V XL	10,100	1,074	1.5	3,375	2,400	95	1.1	1,490
	309 V XL	15,800	2,170	2.0	4,375	5,525	366	1.6	2,480
V2M2.1	175 V XL	5,850	454	1.1	2,480	275	3.7	0.62	495
	245 V XL	10,700	1,164	1.6	3,475	2,400	95	1.1	1,490
	315 V XL	16,550	2,320	2.1	4,475	5,525	366	1.6	2,480
V2.1M1	157 V XL	4,725	330	1.2	2,230	35	0.36	0.43	240
	209 V XL	8,150	756	1.6	2,950	540	21	0.73	980
	261 V XL	12,300	1,426	2.1	3,700	1,220	84	1.0	1,710
E1M4	87E	3,475	72	0.50	1,230	35	0.36	0.38	270
	139E	7,975	264	0.99	1,970	540	21	0.77	1,090
	191E	14,175	645	1.5	2,700	1,230	84	1.1	1,910
	243E	22,075	1,278	2.0	3,450	2,160	212	1.5	2,725
E1M5	105E	4,900	123	0.54	1,490	275	3.7	0.66	550
	175E	11,250	469	1.1	2,480	2,400	95	1.3	1,650
	245E	19,900	1,161	1.6	3,475	5,500	367	2.0	2,750
	315E	30,850	2,314	2.1	4,475	9,825	909	2.6	3,850
E1M6	157 E XL	11,350	425	1.2	2,230	35	0.36	0.55	270
	209 E XL	19,525	972	1.7	2,950	540	21	0.93	1,090
	261 E XL	29,475	1,833	2.1	3,700	1,230	84	1.3	1,910
E1M7	175 E XL	14,000	584	1.1	2,480	275	3.7	0.79	550
	245 E XL	25,625	1,496	1.6	3,475	2,400	95	1.4	1,650
	315 E XL	39,700	2,979	2.1	4,475	5,550	367	2.1	2,750

For SI: 1 in. = 25.4 mm; 1 ft. = 304.8 mm; 1 lb_f = 4.448 N

¹The tabulated values are reference design values intended for Allowable Stress Design (ASD) and must be adjusted in accordance with Section 4.2.

²The CLT layups are developed based on the 2017 ANSI/APA PRG 320, using visually graded sawn lumber noted in Section 3.2.1 of the evaluation report. CLT layups ending with XL in CLT panel thickness designation are manufactured with two laminations with wood grain orientation running in the same direction at the outmost surfaces of the CLT panels.

TABLE 3—REFERENCE DESIGN VALUES FOR IN-PLANE SHEAR OF THE STRUCTURLAM[®] CROSSLAM[®] CLT PANELS¹

CLT LAYUP ⁹	CLT PANEL THICKNESS DESIGNATION	FACE LAMINATION ORIENTATION ² (psi)		FACE LAMINATION ORIENTATION ³ (lb/ft of width)	
		∥ ⁴	⊥ ⁴	∥ ⁴	⊥ ⁴
V2M1	99 V	175 ⁵	235 ⁵	8,200 ⁵	11,000 ⁵
	169 V	175 ⁵	235 ⁵	14,000 ⁵	18,800 ⁵
	239 V	175 ⁵	235 ⁵	19,800 ⁵	26,600 ⁵
	309 V	175 ⁵	235 ⁵	25,600 ⁵	34,300 ⁵
V2M1.1	105V	195	290	9,700	14,400
	175V	270	290 ⁶	22,400	24,000 ⁶
	245V	270 ⁵	290 ⁶	31,300 ⁵	33,600 ⁶
	315V	270 ⁵	290 ⁶	40,200 ⁵	43,200 ⁶
V2.1	87V	175	235	7,200	9,700
	139V	175 ⁵	235 ⁵	11,500 ⁵	15,400 ⁵
	191V	175 ⁵	235 ⁵	15,800 ⁵	21,200 ⁵
	243V	175 ⁵	235 ⁵	20,100 ⁵	27,000 ⁵
V2M2	169 V XL	175 ⁵	235 ⁵	14,000 ⁵	18,800 ⁵
	239 V XL	175 ⁵	235 ⁵	19,800 ⁵	26,600 ⁵
	309 V XL	175 ⁵	235 ⁵	25,600 ⁵	34,300 ⁵
V2M2.1	175 V XL	175 ⁵	235 ⁵	14,500 ⁵	19,500 ⁵
	245 V XL	175 ⁵	235 ⁵	20,300 ⁵	27,200 ⁵
	315 V XL	175 ⁵	235 ⁵	26,100 ⁵	35,000 ⁵
V2.1M1	157 V XL	175 ⁵	235 ⁵	13,000 ⁵	17,500 ⁵
	209 V XL	175 ⁵	235 ⁵	17,300 ⁵	23,200 ⁵
	261 V XL	175 ⁵	235 ⁵	21,600 ⁵	29,000 ⁵
E1M4	87E	175 ⁵	235 ⁵	7,200 ⁵	9,700 ⁵
	139E	175 ⁵	235 ⁵	11,500 ⁵	15,400 ⁵
	191E	175 ⁵	235 ⁵	15,800 ⁵	21,200 ⁵
	243E	175 ⁵	235 ⁵	20,100 ⁵	27,000 ⁵
E1M5	105E	195 ⁷	290 ⁷	9,700 ⁷	14,400 ⁷
	175E	270 ⁷	290 ⁷	22,400 ⁷	24,000 ⁷
	245E	270 ⁷	290 ⁷	31,300 ⁷	33,600 ⁷
	315E	270 ⁷	290 ⁷	40,200 ⁷	43,200 ⁷
E1M6	157 E XL	175 ⁵	235 ⁵	13,000 ⁵	17,500 ⁵
	209 E XL	175 ⁵	235 ⁵	17,300 ⁵	23,200 ⁵
	261 E XL	175 ⁵	235 ⁵	21,600 ⁵	29,000 ⁵
E1M7	175 E XL	175 ⁵	235 ⁵	14,500 ⁵	19,500 ⁵
	245 E XL	175 ⁵	235 ⁵	20,300 ⁵	27,200 ⁵
	315 E XL	175 ⁵	235 ⁵	26,100 ⁵	35,000 ⁵

For SI: 1 psi = 6,895 Pa

¹The tabulated values are reference design values intended for Allowable Stress Design (ASD).

²The tabulated values are ASD reference edgewise shear stress of CLT in the major strength direction ($F_{v,e,0}$) and minor strength direction ($F_{v,e,90}$).

³The tabulated values are ASD reference edgewise shear capacity of the full thickness of the CLT in the major strength direction ($F_{v,e,0} t_p$) and minor strength direction ($F_{v,e,90} t_p$). The values shall be reduced when the CLT panel thickness is less than the full thickness of the CLT panels (t_p) specified in Table 1.

⁴"∥" indicates the parallel to the major strength direction of the CLT. "⊥" indicates the perpendicular to the major strength direction of the CLT.

⁵Based on test results from 175V of V2M1.1.

⁶Based on test results from 105V of V2M1.1.

⁷Based on test results from V2M1.1.

⁸Based on test results from 87V of V2.1.

⁹The CLT layouts are developed based on the 2017 ANSI/APA PRG 320, using visually graded sawn lumber noted in Section 3.2.1 of the evaluation report. CLT layouts ending with XL in CLT panel thickness designation are manufactured with two laminations with wood grain orientation running in the same direction at the outmost surfaces of the CLT panels.



FIGURE 1—COMPANY LOGO FOR STRUCTURLAM MASS TIMBER CORPORATION



FIGURE 2—TYPICAL 3-PLY and 5-PLY STRUCTURLAM CROSSLAM® CLT PANEL LAYUPS

DISCLAIMER

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REPORT HOLDER:

STRUCTURLAM MASS TIMBER CORPORATION

EVALUATION SUBJECT:

STRUCTURLAM CROSSLAM® CLT

1.0 REPORT PURPOSE AND SCOPE

Purpose:

The purpose of this evaluation report supplement is to indicate that Structurlam CrossLam® cross-laminated timber (CLT) panels, described in ICC-ES master evaluation report [ESR-3631](#), have also been evaluated for compliance with the codes noted below as adopted by the Los Angeles Department of Building and Safety (LADBS).

Applicable code editions:

- 2017 *City of Los Angeles Building Code* (LABC)
- 2017 *City of Los Angeles Residential Code* (LARC)

2.0 CONCLUSIONS

The Structurlam CrossLam® CLT panels, described in Sections 2.0 through 7.0 of the master evaluation report [ESR-3631](#), comply with the LABC Chapters 6 and 23, and the LARC, and are subjected to the conditions of use described in this supplement.

3.0 CONDITIONS OF USE

The Structurlam CrossLam® CLT panels, described in this evaluation report supplement must comply with all of the following conditions:

- All applicable sections in the master evaluation report [ESR-3631](#).
- The design, installation, conditions of use and identification are in accordance with the 2018 or 2015 *International Building Code*® (IBC) provisions noted in the master evaluation report [ESR-3631](#).
- The design, installation and inspection are in accordance with additional requirements of LABC Chapters 16 and 17, as applicable.

This supplement expires concurrently with the master report [ESR-3631](#), reissued September 2019.