CONSTRUCTION

Evaluation Report CCMC 13543-R
Global LVL

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1. Opinion

It is the opinion of the Canadian Construction Materials Centre (CCMC) that "Global LVL," 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) of 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) of 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:
  - Sentence 9.23.4.2.(3), Spans for Joists, Rafters and Beams

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

Ruling No. 11-02-260 (13543-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 2011-05-25 (revised on 2011-08-16) 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 veneer lumber (LVL) that is available in several structural grades as outlined in the tables in this Report. The LVL product is manufactured by laminating veneers of either:

- all aspen veneers, or
- a mixed species of aspen/birch veneers.

The grain of the veneers is oriented to the length of the member. The 3.2-mm-thick veneers are bonded with a phenol-formaldehyde adhesive and laid end to end with a slight overlap. Veneer layers are laid one on top of the other such that the scarf and lap joints in one layer are staggered in relation to those in the adjacent layer. The veneer assembly is hot pressed under computer-controlled time, pressure and temperature cycles. The product is then machined to the required depth and length after curing.

The product is available in thicknesses ranging from 19 mm to 76 mm, depths ranging from 45 mm to 1 220 mm, and lengths up to 18 m.

The phenol-formaldehyde adhesive complies with CSA O112.10-08, "Evaluation of Adhesives for Structural Wood Products (Limited Moisture Exposure)" (CCMC 14111-L).

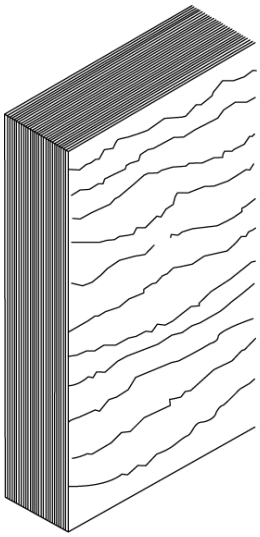

Figure 1. "Global LVL"

3. Conditions and Limitations

CCMC's compliance opinion in Section 1 is bound by the "Global LVL" 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.[1]
- The product is intended for use in construction as an alternative material to lumber. Proprietary design values for the product are to be used by professional engineers to design in accordance with CSA O86 and Part 4, Structural Design, of Division B of the NBC 2015, for use in structural applications such as beams, headers, joists, rafters and columns as intended by the product manufacturer. The specific application must be qualified through specific testing and validated by the manufacturer. Applications such as I-joist flanges, studs and metal-plated truss chords are beyond the scope of this evaluation.

i. Engineering Requirements

The design and installation of the product requires engineering on a case-by-case basis. All drawings and 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. The engineer must design in accordance with CSA O86 and may use the *Engineering Guide for Wood-Frame Construction* published by the Canadian Wood Council as a guide.

The specified strengths and fastener limits for the product must not exceed the values set forth in Tables 4.1.1.1 to 4.1.1.4 in this Report.

When the product is used as a beam member, the ends of all beams must be restrained to prevent rollover. This is normally achieved by attaching a diaphragm sheathing to the top or to the compression edge, and to an end wall or shear transfer panel capable of transferring a minimum unfactored uniform load of 730 N/m or the required shear forces due to wind or seismic conditions. Blocking or cross-bracing with equivalent strength may be used. For beams with a maximum depth-to-width ratio of no more than 6.5:1, the compression edge of the beams must be laterally supported at least every 610 mm. When the depth-to-width ratio exceeds 6.5:1, the compression edge of the beams must be continuously laterally supported through its length, except where the design is done in accordance with CSA O86.

ii. Engineering Support Provided by Manufacturer

Global LVL Inc. will coordinate the engineering support and may be contacted at:

Tel.: 819-629-3600
Fax.: 819-629-3602

(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%, according to 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.

4. Technical Evidence

The Report Holder has submitted technical documentation for CCMC's 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 Strength and Modulus of Elasticity for "Global LVL" (Aspen), 2850Fb-1.9E and 2800Fb-1.7E[(1)(2)]

Property	LVL Orientation[(3)]			
	2850Fb-1.9E		2800Fb-1.7E	
	Joist	Plank	Joist	Plank
Bending (f_b)[(4)(5)] (MPa)	31.5	31.5	35.7	35.7
Shear-free modulus of elasticity (E_{true})[(6)] (MPa)	13,100	13,100	11,722	11,722
Apparent modulus of elasticity ($E_{apparent}$)[(7)] (MPa)	11,909	11,909	10,656	10,656
Longitudinal shear (f_v) (MPa)	2.83	1.54	2.8	1.9
Compression perpendicular to grain ($f_{c\perp}$) (MPa)	5.42	5.42	6.0	3.5
Compression parallel to grain ($f_{c\parallel}$) (MPa)	20.9		28.6	
Tension parallel to grain (f_t)[(8)] (MPa)	21.7		23.6	

Notes to Table 4.1.1:

(1) The specified strengths are to be used in accordance with CSA O86.

(2) The specified strengths are limited to conditions in which the average moisture content of sawn lumber is less than 16%.

(3) Joist = load parallel to glue line, plank = load perpendicular to glue line.

(4) Tabulated values for specified strength (f_b) may be increased by 4% when member is utilized in load-sharing system as defined in CSA O86.

(5) Based on a reference depth of 304 mm. For other depths, multiply by $(304/d)^{(0.25)}$. Adjustments for common depths are shown below. For depths less than 88 mm, use the multiplier for the 88-mm depth.

Depth and Multiplier

Depth (mm)	88	139	184	241	304	355	406	457
Multiplier	1.36	1.22	1.13	1.06	1.00	0.96	0.93	0.90

(6) For uniformly loaded simple span beams, the deflection shall be calculated as follows:

$$D = \frac{156.25wL^4 \times 10^6}{E_{true}db^3} + \frac{6000wL^2}{E_{true}db}$$

where:

D = deflection (mm)
w = specified uniform load (N/m)
L = span (m)

E_{true} = modulus of elasticity (shear-free) (MPa)
b = beam width (mm)
d = beam depth (mm)

(7) Apparent modulus of elasticity calculated using $E_{true}/E_{apparent} = 1.10$. When used as a compression member, compressive resistance shall be calculated in accordance with CSA O86 where the specified modulus of elasticity is $E_{apparent}$.

(8) Tension values are adjusted to a specified length of 6 096 mm (20 ft.). For longer lengths, the tension values shall be adjusted by $(6\ 096/L)^{(0.146)}$, where L is in mm.

Table 4.1.2 Fastener Capacity Design for "Global LVL" (Aspen), 2850Fb-1.9E and 2800Fb-1.7E(1)

Fastener Property	Nail Orientation or Bolt Size	Load Direction	Equivalent Species Specific Gravity for Fastener Design Purposes	Equivalent Species Specific Gravity for Fastener Design Purposes
			2850Fb-1.9E	2800Fb-1.7E
Nail withdrawal	edge	withdrawal	0.46	0.51
	face	withdrawal		0.52
Lateral nail resistance	edge	parallel to grain	0.43	0.42
		perpendicular to grain		
	face	parallel to grain		0.45
		perpendicular to grain		
Bolt-bearing capacity(2)	12.5 mm	parallel to grain	0.43	0.36
		perpendicular to grain		0.44
	19.0 mm	parallel to grain		0.36
		perpendicular to grain		0.44
Nail spacing into edge	N/A(3)	N/A	N/A	N/A

Notes to Table 4.1.2:

(1) Fastener values determined using equivalent specific gravities are for normal duration and can be adjusted using the load duration factors in accordance with CSA O86.

(2) The bolt edge distance when loaded parallel and perpendicular to the grain shall be a minimum of four times the bolt diameter.

(3) N/A = not available

Table 4.1.3 Specified Strength and Modulus of Elasticity for "Global LVL" (Aspen/Birch), 3300Fb-2.0E and 3025Fb-1.9E[(1)(2)]

Property	LVL Orientation[(3)]			
	3300Fb-2.0E		3025Fb-1.9E	
	Joist	Plank	Joist	Plank
Bending (f_b)[(4)(5)] (MPa)	42.0	42.0	38.5	38.5
Shear-free modulus of elasticity (E_{true})[(6)]	13,800	13,800	13,101	13,101
Apparent modulus of elasticity ($E_{apparent}$)[(7)]	12,545	12,545	11,910	11,910
Longitudinal shear (f_v) (MPa)	3.65	1.80	3.72	1.76
Compression perpendicular to grain ($f_{c\perp}$) (MPa)	7.42	6.21	7.22	6.28
Compression parallel to grain ($f_{c||}$) (MPa)	29.6		29.6	
Tension parallel to grain (f_t)[(8)] (MPa)	29		26.8	

Notes to Table 4.1.3:

(1) The specified strengths are to be used in accordance with CSA O86.

(2) The specified strengths are limited to conditions in which the average moisture content of sawn lumber is less than 16%.

(3) Joist = load parallel to glue line, plank = load perpendicular to glue line.

(4) Tabulated values for specified strength (f_b) may be increased by 4% when member is utilized in load-sharing system as defined in CSA O86.

(5) Based on a reference depth of 304 mm. For other depths, multiply by $(304/d)^{(0.15)}$. Adjustments for common depths are shown below. For depths less than 88 mm, use the multiplier for the 88-mm depth.

Depth and Multiplier

Depth (mm)	88	139	184	241	304	355	406	457
Multiplier	1.20	1.12	1.08	1.04	1.00	0.98	0.96	0.94

(6) For uniformly loaded simple span beams, the deflection shall be calculated as follows:

$$D = \frac{156.25wL^4\times10^6}{E_{true}db^3} + \frac{6000wL^2}{E_{true}db}$$

where:

D = deflection (mm)
w = specified uniform load (N/m)
L = span (m)
E_{true} = modulus of elasticity (shear-free) (MPa)
b = beam width (mm)
d = beam depth (mm)

(7) Apparent modulus of elasticity calculated using $E_{true}/E_{apparent} = 1.10$. When used as a compression member, compressive resistance shall be calculated in accordance with CSA O86 where the specified modulus of elasticity is $E_{apparent}$.

(8) Tension values are adjusted to a specified length of 6 096 mm (20 ft.). For longer lengths, the tension values shall be adjusted by $(6\,096/L)^{(0.146)}$, where L is in mm.

Table 4.1.4 Fastener Capacity Design for Global LVL (Aspen/Birch), 3300Fb-2.0E and 3025-1.9E(1)

Fastener Property	Nail Orientation or Bolt Size	Load Direction	Equivalent Species Specific Gravity for Fastener Design Purposes
Nail withdrawal	**edge**	**withdrawal**	0.50
	face	**withdrawal**	
Lateral nail resistance	**edge**	**parallel to grain**	0.50
		perpendicular to grain	
	face	**parallel to grain**	
		perpendicular to grain	
Bolt bearing capacity(2)	**12.5 mm**	**parallel to grain**	0.50
		perpendicular to grain	
	19.0 mm	**parallel to grain**	
		perpendicular to grain	
Nail spacing into edge	**N/A(3)**	**N/A**	N/A

Notes to Table 4.1.4:

(1) Fastener values determined using equivalent specific gravities are for normal duration and can be adjusted using the load duration factors in accordance with CSA O86.

(2) The bolt edge distance when loaded parallel and perpendicular to the grain shall be a minimum of four times the bolt diameter.

(3) N/A = not available

This Evaluation Report is applicable only to "Global LVL" labeled with the APA–EWS certification mark and the CCMC 13543-R on each beam or header member.

The manufacturing quality assurance program has been updated to include requirements specified in the most recent version of ASTM D 5456, "Evaluation of Structural Composite Lumber Products," and has been verified by APA-EWS as part of the product certification. APA-EWS conducts audits of the manufacturing plants and the quality assurance program.

Report Holder

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Date modified:
2020-03-10

APPENDIX A

The design values are obtained from testing to ASTM D 5456-01, "Evaluation of Structural Composite Lumber Products," was used for original qualification and volume effect exponent determination. The ASTM D 5456-07 was used for the plant re- qualification for the strength of the old and new grades, as specified in CAN/CSA O86-09 and summarized below. The original exponents for volume adjustments being used was reaffirmed by the certification agency to ASTM D 5456-13a.

Table A1. Additional Test Information for "Global LVL"

Property	Test Information
Bending	A total of 216 specimens were originally tested in edgewise and flatwise bending. Qualification test data was used to establish the applicable coefficient of variation, CV_W, and the reliability normalization factor from CAN/CSA O86 was used to determine the specified strength. For requalification, 53 specimens of 2850Fb-1.9E (edgewise) and 3300Fb-2.0E (edgewise) grades were tested. For new qualification, 53 specimens of 3025Fb-1.9E (edgewise) and 2800Fb-1.7E (edgewise and flatwise) grades were tested.
Modulus of elasticity	Shear-free modulus of elasticity was established during the initial qualification. Testing and analysis by APA following the procedures of Sections 45 through 52 of Appendix X4 of ASTM D 198-15, "Standard Test Methods of Static Tests of Lumber in Structural Size," was conducted to determine $E_{true}/E_{apparent}$ for 3300Fb-2.0E. Ratios of 1.08 and 1.10 were determined for edgewise bending and flatwise bending, respectively. The conservative ratio of 1.10 was selected for all grades and species to determine $E_{apparent}$. The corresponding conservative E_{true}/G ratio of 40 was selected for the derivation of the deflection equation instead of the typically assumed ratio of 16.
Shear	A total of 240 specimens were originally tested parallel and perpendicular to grain as well as to the glue line to establish the characteristic value. Qualification test data was used to establish the applicable coefficient of variation, CV_W, and the reliability normalization factor from CAN/CSA O86 was used to determine the specified strength. For requalification, 53 specimens of 2850Fb-1.9E and 3300Fb-2.0E grades were tested in both plank and the flatwise orientation. For new qualification, 53 specimens of 3025Fb-1.9E (plank only) and 2800Fb-1.7E grade were tested in both plank and the flatwise orientation.
Compression parallel to grain	A total of 60 specimens were tested to establish the characteristic value. Qualification test data was used to establish the applicable coefficient of variation, CV_W, and the reliability normalization factor from CAN/CSA O86 was used to determine the specified strength. For new qualification, 53 specimens of 2800Fb-1.7E were tested and no specimens of 3025Fb-1.9E were tested.
Compression perpendicular to grain	A total of 120 specimens were tested in edge and plank compression to establish the characteristic value. The characteristic value was multiplied by 1.09 to establish the specified strength in accordance with CAN/CSA O86. For new qualification, 30 specimens of 2800Fb-1.7E were tested and no specimens of 3025Fb-1.9E were tested.
Tension parallel to grain	A total of 184 specimens were tested to establish the characteristic value and volume adjustment exponent. Qualification test data was used to establish the applicable coefficient of variation, CV_W, and the reliability normalization factor from CAN/CSA O86 was used to determine the specified strength. For requalification, 53 specimens of 2850Fb-1.9E and 3300Fb-2.0E grades were tested. For new qualification, 53 specimens of 3025Fb-1.9E and 2800Fb-1.7E grades were tested.
Nail withdrawal	Nail withdrawal values were established following ASTM D 1761-06 for an 8d common nail having a 38-mm penetration. Specimens were tested and an equivalent species capacity was determined in accordance with ASTM D 5456, A2. For new qualification, 15 specimens of 2800Fb-1.7E grade were tested.
Nail lateral resistance	Dowel bearing strength was determined in accordance with ASTM D 5764-97a(2007) with 10d common nails with a nominal diameter of 3.76 mm. Specimens were tested and the mean bearing capacity was used to establish the equivalent species capacity as per ASTM D 5456, A2. For new qualification, 15 specimens of 2800Fb-1.7E grade were tested.
Bolt bearing	Bolt bearing capacity was determined in accordance with ASTM D 5764 with 13-mm and 19-mm bolts. Specimens were tested and the mean bolt bearing capacity was used to establish the equivalent species capacity in accordance with ASTM D 5456, A2. For new qualification, 15 specimens of 2800Fb-1.7E grade were tested.
Creep and recovery	In the initial qualification, 30 specimens of mixed birch/aspen were tested within a four-month creep and recovery test program, resulting in acceptable performance demonstrating equivalency to the duration of load behaviour of lumber.

Product durability	The SCL product durability was tested as per Annex A4.3 of a more recent edition of ASTM D 5456-09, not currently required in the 2007 version specified in CAN/CSA O86-09.
Adhesive	The adhesive used is a high-temperature cure phenol-resorcinol that has demonstrated compliance with CSA O112.10-08 (CCMC 14111-L).
Quality assurance	The manufacturing quality assurance program includes audits by APA-EWS that are conducted as part of the product certification.