APA PRODUCT REPORT®

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Vaagen Cross-Laminated Timber
Vaagen Timbers, LLC

PR-L328

Revised January 9, 2024

Products: Vaagen Cross-Laminated Timber
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1. Basis of the product report:
   - 2021, 2018, and 2015 International Building Code (IBC): Section 2303.1.4 Structural glued cross-laminated timber
   - 2012 IBC: Section 104.11 Alternative materials
   - 2021, 2018, and 2015 International Residential Code (IRC): Sections R502.1.6, R602.1.6, and R802.1.6 Cross-laminated timber
   - 2012 IRC: Section R104.11 Alternative materials
   - ANSI/APA PRG 320-2019 Standard for Performance-Rated Cross-Laminated Timber recognized in the 2021 IBC and IRC
   - ANSI/APA PRG 320-2017, PRG 320-2012, and PRG 320-2011 recognized in the 2018 IBC and IRC, 2015 IRC, and 2015 IBC, respectively
   - APA Reports T2019P-38, T2021P-41, T2022P-05, T2023P-05, T2023P-14, and T2023P-50, PFS TECO Reports No. 20-016 (Rev. 21-08-17), No. 20-089, No. 20-090, No. 20-522, No. 21-068, No. 21-187, and No. 21-583, and other qualification data

2. Product description:
   Vaagen cross-laminated timber (CLT) is manufactured with softwood lumber in accordance with custom layups of ANSI/APA PRG 320 approved by APA through product qualification and/or mathematical models using principles of engineering mechanics. Allowable design properties for lumber laminations used in Vaagen CLT are provided in Table 1. Vaagen CLT is permitted for use in floor, roof, and wall applications, and is manufactured with nominal widths up to 48 inches, thicknesses of 4-1/8 to 9-5/8 inches, and lengths up to 60 feet.

3. Design properties:
   Vaagen CLT shall be designed with the allowable design properties and capacities provided in Table 2. The design value adjustment factors shall be based on Table 10.3.1 of the 2018 ANSI/AWC National Design Specification for Wood Construction (NDS) and approved by the engineer of record. The lateral resistance of Vaagen CLT, when used as shear walls or diaphragms, depends on the panel-to-panel connection and anchorage designs, and shall be designed in accordance with Sections 4.4 and 4.5 of the 2021 ANSI/AWC Special Design Provisions for Wind and Seismic (SDPWS), or consulted with the CLT manufacturer and approved by the engineer of record.

   Design values for the Load and Resistance Factor Design (LRFD) used in the U.S. for Vaagen CLT can be derived from the ASD values published in Table 2 of this report in accordance with Tables 10.3.1, N1, N2, and N3 of the 2018 NDS.

4. Product installation:
   Vaagen CLT shall be installed in accordance with the recommendations provided by the manufacturer (www.vaagentimbers.com) and the engineering drawing approved by the engineer of record. Permissible details shall be in accordance with the engineering drawing.

5. Fire-rated assemblies:
   Fire-rated assemblies shall be constructed in accordance with the recommendations provided by the manufacturer (see link above). Procedures specified in Chapter 16 of the NDS shall be permitted for use in designing Vaagen CLT for a fire exposure up to 2 hours.

6. Limitations:
   a) Vaagen CLT shall be designed in accordance with principles of mechanics using the design properties specified in this report or provided by the manufacturer.
   b) Vaagen CLT shall be limited to dry service conditions where the average equilibrium moisture content of solid-sawn lumber is less than 16%.
   c) Design properties for Vaagen CLT, when used as beams or lintels with loads applied parallel to the face-bond gluelines, are beyond the scope of this report.
   d) Vaagen CLT shall be manufactured in compliance with ANSI/APA PRG 320 and documented in the Vaagen Timbers, LLC's in-plant manufacturing standard approved by APA.
   e) Vaagen CLT is produced at the Colville, Washington facility under a quality assurance program audited by APA.
   f) This report is subject to re-examination in one year.

7. Identification:
   Vaagen CLT described in this report is identified by a label bearing the manufacturer's name (Vaagen Timbers, LLC) and/or trademark, the APA assigned plant number (1129), the product standard (ANSI/APA PRG 320), the APA logo, the CLT grade and thickness (or layup ID), the report number PR-L328, and a means of identifying the date of manufacture.

Table 1. ASD Reference Design Values[a] for Lumber Laminations Used in Vaagen CLT (for Use in the U.S.)

CLT Grade	Laminations Used in Major Strength Direction									Laminations Used in Minor Strength Direction								
	Grade & Species	F_b (psi)	E (10^6 psi)	F_t (psi)	F_c (psi)	F_v (psi)	F_s (psi)	$F_{c\perp}$ (psi)	G	Grade & Species	F_b (psi)	E (10^6 psi)	F_t (psi)	F_c (psi)	F_v (psi)	F_s (psi)	$F_{c\perp}$ (psi)	G
V1M3	No. 2 DF	900	1.35[b]	575	1,350	180	60	625	0.50	No. 2 DF	900	1.35[b]	575	1,350	180	60	625	0.50
V2M8	No. 1/No. 2 SPF	875	1.4	450	1,150	135	45	425	0.42	No. 1/No. 2 SPF	875	1.4	450	1,150	135	45	425	0.42
V3M8	No. 2 SP	750	1.4	450	1,250	175	55	565	0.55	No. 2 SP	750	1.4	450	1,250	175	55	565	0.55
V4M2	No. 2 SPF-S	775	1.1	350	1,000	135	45	335	0.38	No. 2 SPF-S	775	1.1	350	1,000	135	45	335	0.38
V5M3(N)	No. 1/No. 2 HF (N)	1,000	1.6	575	1,450	145	45	405	0.46	No. 1/No. 2 HF (N)	1,000	1.6	575	1,450	145	45	405	0.46
E2M5	2400f-2.0E DF	2,400	2.0	1,925	1,975	180	60	670	0.51	2400f-2.0E DF	2,400	2.0	1,925	1,975	180	60	670	0.51

For SI: 1 psi = 0.006895 MPa

[a] Tabulated values are allowable design values and not permitted to be increased for the lumber flat use or size factor in accordance with the NDS. The design values shall be used in conjunction with the section properties provided by the CLT manufacturer based on the actual layup used in manufacturing the CLT panel (see Table 2).

[b] Modulus of elasticity used for the derivation of CLT reference design values.

Table 2. ASD Reference Design Values[a, b] for Vaagen CLT (for Use in the U.S.)

CLT Grade[c]	Layup ID[d]	CLT Thick-ness, t_p (in.)	Lamination Thickness (in.) in CLT Layup							Major Strength Direction				Minor Strength Direction			
			=	⊥	=	⊥	=	⊥	=	$(F_bS)_{eff,f,0}$ (lbf-ft/ft)	$(EI)_{eff,f,0}$ (10^6 lbf-in.^{2}/ft)	$(GA)_{eff,f,0}$ (10^6 lbf/ft)	$V_{s,0}$ (lbf/ft)	$(F_bS)_{eff,f,90}$ (lbf-ft/ft)	$(EI)_{eff,f,90}$ (10^6 lbf-in.^{2}/ft)	$(GA)_{eff,f,90}$ (10^6 lbf/ft)	$V_{s,90}$ (lbf/ft)
V1M3	DFL3	4 1/8	1 3/8	1 3/8	1 3/8					2,090	91	0.51	1,980	285	3.5	0.51	660
	DFL5	6 7/8	1 3/8	1 3/8	1 3/8	1 3/8	1 3/8			4,825	350	1.0	3,300	2,460	91	1.0	1,980
	DFL7	9 5/8	1 3/8	1 3/8	1 3/8	1 3/8	1 3/8	1 3/8	1 3/8	8,525	868	1.5	4,625	5,675	350	1.5	3,300
V2M8	SPF3	4 1/8	1 3/8	1 3/8	1 3/8					2,030	95	0.52	1,490	275	3.6	0.52	495
	SPF5	6 7/8	1 3/8	1 3/8	1 3/8	1 3/8	1 3/8			4,675	363	1.1	2,480	2,390	95	1.1	1,490
	SPF7	9 5/8	1 3/8	1 3/8	1 3/8	1 3/8	1 3/8	1 3/8	1 3/8	8,275	900	1.6	3,475	5,500	363	1.6	2,480
V3M8	SP3	4 1/8	1 3/8	1 3/8	1 3/8					1,740	95	0.52	1,820	235	3.6	0.52	605
V4M2	SPFS3	4 1/8	1 3/8	1 3/8	1 3/8					1,800	74	0.41	1,490	245	2.9	0.41	495
	SPFS5	6 7/8	1 3/8	1 3/8	1 3/8	1 3/8	1 3/8			4,150	286	0.83	2,480	2,120	74	0.83	1,490
	SPFS7	9 5/8	1 3/8	1 3/8	1 3/8	1 3/8	1 3/8	1 3/8	1 3/8	7,325	707	1.2	3,475	4,875	286	1.2	2,480

Table 2. ASD Reference Design Values[a, b] for Vaagen CLT (for Use in the U.S.) (continued)

CLT Grade[c]	Layup ID[d]	CLT Thick-ness, t_p (in.)	Lamination Thickness (in.) in CLT Layup							Major Strength Direction				Minor Strength Direction			
			=	⊥	=	⊥	=	⊥	=	$(F_bS)_{eff,f,0}$ (lbf-ft/ft)	$(EI)_{eff,f,0}$ (10^6 lbf-in.^{2}/ft)	$(GA)_{eff,f,0}$ (10^6 lbf/ft)	$V_{s,0}$ (lbf/ft)	$(F_bS)_{eff,f,90}$ (lbf-ft/ft)	$(EI)_{eff,f,90}$ (10^6 lbf-in.^{2}/ft)	$(GA)_{eff,f,90}$ (10^6 lbf/ft)	$V_{s,90}$ (lbf/ft)
V5M3(N)	HF(N)3	4 1/8	1 3/8	1 3/8	1 3/8					2,320	108	0.60	1,490	315	4.2	0.60	495
E2M5	DFL3	4 1/8	1 3/8	1 3/8	1 3/8					5,575	135	0.75	1,980	755	5.2	0.75	660
	DFL5	6 7/8	1 3/8	1 3/8	1 3/8	1 3/8	1 3/8			12,850	519	1.5	3,300	6,575	135	1.5	1,980
	DFL7	9 5/8	1 3/8	1 3/8	1 3/8	1 3/8	1 3/8	1 3/8	1 3/8	22,700	1,286	2.2	4,625	15,100	519	2.3	3,300

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

[a] Tabulated values are allowable design values and not permitted to be increased for the lumber flat use or size factor in accordance with the NDS.

[b] Deflection under a specified uniformly distributed load, w, acting perpendicular to the face of a single-span CLT panel shall be permitted to be calculated as a sum of the deflections due to moment and shear effects using the effective bending stiffness, $(EI)_{eff}$, and the effective in-plane (planar) shear rigidity, $(GA)_{eff}$, as follows:

$$\delta = \frac{22.5wL^4}{(EI)_{eff}} + \frac{9wL^2}{5(GA)_{eff}} \quad [1]$$

where: δ = estimated deflection, inches;
w = uniform load, lbf/ft^2;
L = span, feet;
$(EI)_{eff}$ = tabulated effective bending stiffness, lbf-in.^{2}/ft; and
$(GA)_{eff}$ = tabulated effective in-plane (planar) shear rigidity, lbf/ft.

For a concentrated load, P, located in the middle of a single span CLT panel acting perpendicular to the panel, the deflection shall be permitted to be calculated as follows:

$$\delta = \frac{36PL^3}{(EI)_{eff}} + \frac{18PL}{5(GA)_{eff}} \quad [2]$$

where: δ = estimated deflection, inches;
P = concentrated load, lbf/ft of width;
L = span, feet;
$(EI)_{eff}$ = tabulated effective bending stiffness, lbf-in.^{2}/ft; and
$(GA)_{eff}$ = tabulated effective in-plane (planar) shear rigidity, lbf/ft.

[c] The CLT grade and layups are developed based on ANSI/APA PRG 320, as permitted by the standard.

[d] The layup identification (ID) refers to lumber lamination species and number of layers.

APA – The Engineered Wood Association is an approved national standards developer accredited by American National Standards Institute (ANSI). APA publishes ANSI standards and Voluntary Product Standards for wood structural panels and engineered wood products. APA is an accredited certification body under ISO/IEC 17065 by Standards Council of Canada (SCC), an accredited inspection agency under ISO/IEC 17020 by International Code Council (ICC) International Accreditation Service (IAS), and an accredited testing organization under ISO/IEC 17025 by IAS. APA is also an approved Product Certification Agency, Testing Laboratory, Quality Assurance Entity, Validation Entity, and Product Evaluation Entity by the State of Florida, and an approved testing laboratory by City of Los Angeles.

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