



LISTING INFORMATION OF
**KLH Massivholz GmbH – Massivholzplatten (solid wood
slabs) CLT**
SPEC ID: 36204

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LISTING INFORMATION

KLH-Massivholzplatten (solid wood slabs) cross laminated timber (CLT) is a wood structural building element for walls, floors (ceilings) and roofs. The CLT panels consist of 3 to 8 layers of Austrian Spruce lumber boards stacked crosswise (layers at 90°) and glued on their wide faces. Some panel layups include two adjacent surface layers and/or two adjacent central layers that are arranged parallel to each other. The CLT panels are offered in a maximum length of 54 ft 2 in. (16.5 m); widths of 7 ft 10 in. (2.40m), 8 ft 2 in. (2.50m), 8 ft 11 in. (2.73m) and 9 ft 8 in. (2.95 m); maximum thickness of 1 ft 1/2 in. (0.32 m).

CODE COMPLIANCE RESEARCH REPORT

Evaluation Method	Building Code	CCRR Number
ICC-ES AC455	2021 and 2018 IBC 2021 and 2018 IRC 2022 California Building Code	CCRR-0434

FLAME SPREAD RATINGS

Test Standard	Flame Spread Index	Smoke Developed Index
ASTM E84	75 or less	450 or less

ASTM E119 FIRE RATINGS

Panel Layup	Restricted Load Condition	Duration Rating	CCRR Number
130 5s TL (Roof) ¹	27% of Max Load Condition	60 min w/ hose	CCRR-0434
160 5s TL (Floor)	71% of Max Load Condition	60 min w/ hose	CCRR-0434
175 5s TL (Floor)	36% of Max Load Condition	120 min w/hose	CCRR-0434
175 5s TL (Wall)	12% of Max Load Condition	120 min w/hose	CCRR-0434
180 5s TL (Floor)	53% of Max Load Condition	120 min w/hose	CCRR-0434

¹See CCRR-0434 for details of roof assembly.

MATERIAL RATINGS

Test Standard	Test Type	Rating
ANSI/APA PRG 320	Performance Rated CLT	Custom Layup CV3M1

For Use in the U.S.

Grade	Laminations in Major Strength Direction (psi)						Laminations in Minor Strength Direction (psi)					
	F _{b,0}	E ₀ (10 ⁶)	F _{t,0}	F _{c,0}	F _{v,0}	F _{s,0}	F _{b,90}	E ₉₀ (10 ⁶)	F _{t,90}	F _{c,90}	F _{v,90}	F _{s,90}
CV3M1	975	1.6	550	1,450	175	55	975	1.6	550	1,450	175	55

Tabulated values are allowable design values and not permitted to be increased for the lumber size adjustment factor in accordance with the NDS. The design values shall be used in conjunction with the section properties provided by KLH based on the actual layup used in manufacturing the CLT panel.

For Use in Canada

Grade	Laminations in Major Strength Direction (MPa)						Laminations in Minor Strength Direction (MPa)					
	F _{b,0}	E ₀	F _{t,0}	F _{c,0}	F _{v,0}	F _{s,0}	F _{b,90}	E ₉₀	F _{t,90}	F _{c,90}	F _{v,90}	F _{s,90}

CV3M1	10.8	11,000	5.5	15.0	1.8	0.60	10.8	11,000	5.5	15.0	1.8	0.60
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Tabulated values are Limit States design values and not permitted to be increased for the lumber size adjustment factor in accordance with the CSA O86. The design values shall be used in conjunction with the section properties provided by KLH based on the actual layup used in manufacturing the CLT panel.

Attribute	Value
Code Reports	Yes
Criteria	ANSI / APA PRG 320 (2018)
Criteria	ASTM E119 (2019)
Criteria	ASTM E84 (2018b)
Criteria	ICC-ES AC455 (2021)
Criteria	ANSI / APA PRG 320 (2019)
CSI Code	06 17 19 Cross-Laminated Timber
Intertek Services	Certification
Intertek Services	Code Compliance Research Report
Listed or Inspected	LISTED
Listing Section	BUILDING PANELS
Report Number	G102232156, G103136174, G103855227, G104162725, G104769676
Spec ID	36204
Verification Testing	No

Issue Date: 11-29-2021
Revision Date: 11-17-2023
Renewal Date: 11-30-2024

DIVISION: 06 00 00 – WOOD, PLASTICS, AND COMPOSITES
Section: 06 17 19 – Cross-laminated Timber

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REPORT SUBJECT:
KLH Massivholzplatten CLT

1.0 SCOPE OF EVALUATION

1.1 This Research Report addresses compliance with the following Codes:

- 2021 and 2018 *International Building Code*® (IBC)
- 2021 and 2018 *International Residential Code*® (IRC)
- 2022 *California Building Code* (see Section 9)

NOTE: This report references the most recent Code editions noted. Section numbers in earlier editions may differ.

1.2 KLH Massivholzplatten CLT has been evaluated for the following properties (see Table 1):

- Structural properties
- Surface-burning characteristics
- Fire resistance

1.3 KLH Massivholzplatten CLT has been evaluated for the following uses (see Table 1):

- Use as components in roofs and floors in Types I and II construction
- Use as interior walls, roofs, and floors in Type III construction
- Use as walls, roofs, and floors in Type IV construction (See Section 6)
- Use as walls, roofs, and floors in Type V construction

2.0 STATEMENT OF COMPLIANCE

KLH Massivholzplatten CLT complies with the Codes listed in Section 1.1, for the properties stated in Section 1.2 and uses stated in Section 1.3, when installed as described in this report, including the Conditions of Use stated in Section 6.

3.0 DESCRIPTION

3.1 General: KLH Massivholzplatten (solid wood slabs) cross laminated timber (CLT) is a wood structural building element for walls, floors (ceilings) and roofs. The CLT panels consist of 3 to 8 layers stacked crosswise (layers at 90°) and glued on their wide faces. Some panel layouts include two adjacent surface layers and/or two adjacent central layers that are arranged parallel to each other. Refer to Tables 3 through 6 for available panel layouts.

The CLT panels are offered in a maximum length of 54 ft 2 in. (16.5 m); standard widths of 7 ft 10 in. (2.40m), 8 ft 2 in. (2.50m), 8 ft 11 in. (2.73m) and 9 ft 8 in. (2.95 m); and a maximum thickness of 1 ft 1/2 in. (0.32 m).

3.2 Wood laminations: KLH Massivholzplatten CLT is comprised of laminations of Austrian Spruce having the reference design values listed in Table 2.

3.3 Adhesives: Adhesives used to face-bond layers of KLH Massivholzplatten CLT and for finger-joints of the lamella are one-component formaldehyde-free PUR adhesives conforming to ANSI/APA PRG 320-2019.

4.0 PERFORMANCE CHARACTERISTICS

4.1 Reference Design Values: Tables 7 through 10 of this Report contain reference design values for bending, shear, and compression capacities of the CLT panels. Table 11 contains reference design values for in-plane shear of the CLT panels. The reference design values in Tables 7 through 11 are intended for use in Allowable Stress Design (ASD) and must be adjusted as indicated in Section 4.2. For use in Load and Resistance Factor Design (LRFD), the ASD values



shall be multiplied by the appropriate factors specified in Table 10.3.1 of the AWC NDS.

4.2 Adjustment Factors: The reference design values specified in Tables 7 through 11 of this Report must be adjusted using the appropriate factors specified in Table 10.3.1 of the AWC NDS. Values are not permitted to be increased for the lumber size adjustment factor in accordance with the AWC NDS.

In accordance with Section 3.5.2 of the AWC NDS, a time-dependent deformation creep factor (K_{cr}) of 2.0 shall apply when calculating total deflection under long-term loading.

4.3 Axial Compression: Tables 12 through 14 of this Report contain axial compression load capacity values for the CLT panels. These values are intended for use in Allowable Stress Design (ASD) and are subject to the conditions noted in the tables. For use in Load and Resistance Factor Design (LRFD), the ASD values shall be multiplied by the appropriate factors specified in Table 10.3.1 of the AWC NDS. Panels subject to a combined in-plane axial compression and out-of-plane transverse loading shall be proportioned in accordance with Sections 3.9.2 and 15.4 of the AWC NDS.

4.4 Fire Resistance: KLH Massivholzplatten CLT layups certified by Intertek to comply with the requirements of ASTM E119 are listed in Table 15 of this Report. The fire resistance rating of layups not included in Table 15 shall be determined by calculation in accordance with Chapter 16 of the AWC NDS.

4.5 Surface-burning Characteristics: The KLH Massivholzplatten CLT has a flame-spread index of 75 or less and a smoke-developed index of 450 or less, when tested in accordance with ASTM E84.

5.0 INSTALLATION

5.1 General:

KLH Massivholzplatten CLT must be installed in accordance with the manufacturer's published installation instructions, the applicable Code, and this Research Report. A copy of the manufacturer's instructions must be available on the jobsite during installation.

6.0 CONDITIONS OF USE

6.1 Installation must comply with this Research Report, the manufacturer's published installation instructions, and the applicable Code. In the event of a conflict, this report governs.

6.2 Cutting, drilling, and notching of KLH Massivholzplatten CLT panels has not been evaluated and is outside the scope of this Report.

6.3 The in-plane shear values listed in Table 11 are applicable for in-plane shear design of CLT diaphragms. The complete diaphragm designs have not been evaluated and are outside the scope of this Report.

6.4 Panels used to resist in-plane shear forces in floor and roof diaphragms shall be accompanied by detailing to complete load path(s) for diaphragm design in accordance with Section 4.5 of the 2021 AWC SDPWS.

6.5 Panels used as roofs shall be covered with approved roof coverings secured to the building or structure in accordance with applicable provisions of Chapter 15 of the IBC.

6.6 Panels used to resist gravity or out-of-plane transverse forces in walls shall be accompanied by complete detailing and wall design acceptable to the code official.

6.7 Panels used to resist in-plane shear forces in shear walls shall be accompanied by detailing to complete load path(s) for shear wall design in accordance with Appendix B of the 2021 AWC SDPWS.

6.8 Panels are limited to use in dry service conditions where the moisture content in service is less than 16%.

6.9 Connections between wall panels and roof/floor panels, and other support members shall be accompanied by complete detailing and design acceptable to the code official. Fasteners and connectors shall be properly specified, including size, length, dimension, fastener bearing length, and location. Connections shall be designed in accordance with the mechanical connection provisions in the AWC NDS or proprietary connectors and fasteners evaluated in a current code evaluation report.





6.9.1 Periodic special inspections shall be conducted in accordance with the applicable requirements of Sections 1704 and 1705 of the IBC.

6.9.2 KLH Massivholzplatten CLT panels are permitted to be used as components in walls, floors, and roofs under the IRC when engineered design is submitted in accordance with Section R301.1.3.

6.9.3 KLH Massivholzplatten CLT panels used in Type IV construction must be protected with noncombustible protection in accordance with Section 602.4 of the IBC.

6.10 KLH Massivholzplatten CLT panels used as floors, interior walls, or exterior walls in Type IV construction shall be a minimum of 4 inches thick.

6.11 KLH Massivholzplatten CLT panels used as roof elements in Type IV construction shall be a minimum of 3 inches thick.

6.12 KLH Massivholzplatten CLT panels are manufactured under a quality control program with inspections by Intertek Testing Services NA, Inc.

7.0 SUPPORTING EVIDENCE

7.1 Reports of tests in accordance with ASTM E84 and ASTM E119.

7.2 Data in accordance with the ICC-ES Acceptance Criteria for Cross-laminated Timber Panels for Use as Components in Walls, Floors, and Roofs (AC455), approved February 2021.

7.3 Data in accordance with ANSI/APA PRG 320-19, *Standard for Performance-rated Cross-laminated Timber*.

7.4 Intertek Listing Report "KLH Massivholz GmbH – Massivholzplatten (solid wood slabs) CLT", on the [Intertek Directory of Building Products](https://bpdirectory.intertek.com).

8.0 IDENTIFICATION

The KLH Massivholzplatten CLT panels are identified with the manufacturer's name, the product name, the panel grade and layup, the Intertek Mark as shown below, the Intertek Control Number, and the Code Compliance Research Report number (CCRR-0434).



9.0 CALIFORNIA BUILDING CODE

9.1 Scope of Evaluation:

The KLH Massivholzplatten CLT panels were evaluated for compliance with Chapters 6 and 23 of the 2022 California Building Code.

9.2 Conclusion:

The KLH Massivholzplatten CLT panels, described in this Research Report, comply with Chapters 6 and 23 of the California Building Code when installed in accordance with the applicable requirements of that code. Use of the CLT panels as part of the seismic force-resisting system is outside the scope of this report.

10.0 CODE COMPLIANCE RESEARCH REPORT USE

10.1 Approval of building products and/or materials can only be granted by a building official having legal authority in the specific jurisdiction where approval is sought.

10.2 Code Compliance Research Reports shall not be used in any manner that implies an endorsement of the product by Intertek.

10.3 Reference to the <https://bpdirectory.intertek.com> is recommended to ascertain the current version and status of this report.

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TABLE 1 - PROPERTIES EVALUATED

PROPERTY	2021 IBC SECTION	2021 IRC SECTION	2022 CBC SECTION
Physical Properties	2303.1.4	R502.1.6 R602.1.6 R802.1.6	2303.1.4
Surface-burning Characteristics	803.1.2	R302.9	803.1.2
Type IV Construction	602.4	NA	602.4
Fire Resistance	703.2	R302	703.2

Note: Section numbers in earlier editions of the code may differ

TABLE 2 – ASD REFERENCE DESIGN VALUES FOR LAMELLA USED IN KLH MASSIVHOLZPLATTEN CLT PANELS

Grade	Laminations in Major Strength Direction (psi)						Laminations in Minor Strength Direction (psi)					
	F _{b,0}	E ₀ (x10 ⁶)	F _{t,0}	F _{c,0}	F _{v,0}	F _{s,0}	F _{b,90}	E ₉₀ (x10 ⁶)	F _{t,90}	F _{c,90}	F _{v,90}	F _{s,90}
CV3M1	975	1.6	550	1450	175	55	975	1.6	550	1450	175	55



TABLE 3 – KLH MASSIVHOLZPLATTEN CLT PANEL 3-PLY LAYUPS

CLT LAYUP ¹	PANEL THICKNESS t_p ² (in.)	LAMINATION ACTUAL THICKNESS ³ (in.)		
			⊥	
60 3s TL	2.36	0.79	0.79	0.79
70 3s TL	2.76	0.79	1.18	0.79
80 3s TL	3.15	1.18	0.79	1.18
80 3s TL V2	3.15	0.79	1.57	0.79
90 3s TL	3.54	1.18	1.18	1.18
100 3s TL	3.94	1.57	0.79	1.57
100 3s TL V2	3.94	1.18	1.57	1.18
105 3s TL	4.13	1.38	1.38	1.38
110 3s TL	4.33	1.57	1.18	1.57
120 3s TL	4.72	1.57	1.57	1.57
60 3s TT	2.36	0.79	0.79	0.79
70 3s TT	2.76	0.79	1.18	0.79
80 3s TT	3.15	1.18	0.79	1.18
80 3s TT V2	3.15	0.79	1.57	0.79
90 3s TT	3.54	1.18	1.18	1.18
100 3s TT	3.94	1.18	1.57	1.18
100 3s TT V2	3.94	1.57	0.79	1.57
105 3s TT	4.13	1.38	1.38	1.38
110 3s TT	4.33	1.57	1.18	1.57
120 3s TT	4.72	1.57	1.57	1.57

¹The layups are developed based on ANSI/APA PRG 320, using custom CLT Grade CV3M1. The layup designation refers to the panel thickness (in mm), the number of layers, a layup configuration identifier (“s” for standard perpendicular layers), and a panel orientation identifier (“TT” for major strength direction aligned with the short transverse panel dimension, “TL” for major strength direction aligned with the long longitudinal panel dimension).

²Gross thickness of CLT panels.

³Actual thickness of lamination after planing. “||” denotes parallel to the major strength direction of the panel. “⊥” denotes perpendicular to the major strength direction of the panel.



TABLE 4 – KLH MASSIVHOLZPLATTEN CLT PANEL 5-PLY TL LAYUPS

CLT LAYUP ¹	PANEL THICKNESS t_p ² (in.)	LAMINATION ACTUAL THICKNESS ³ (in.)				
			⊥		⊥	
100 5s TL	3.94	0.79	0.79	0.79	0.79	0.79
110 5s TL	4.33	0.79	0.79	1.18	0.79	0.79
120 5s TL	4.72	1.18	0.79	0.79	0.79	1.18
120 5s TL V2	4.72	0.79	1.18	0.79	1.18	0.79
130 5s TL	5.12	1.18	0.79	1.18	0.79	1.18
130 5s TL V2	5.12	0.79	1.18	1.18	1.18	0.79
140 5s TL	5.51	1.57	0.79	0.79	0.79	1.57
140 5s TL V2	5.51	0.79	1.57	0.79	1.57	0.79
150 5s TL	5.91	1.57	0.79	1.18	0.79	1.57
150 5s TL V2	5.91	1.18	1.18	1.18	1.18	1.18
150 5s TL V3	5.91	0.79	1.57	1.18	1.57	0.79
160 5s TL	6.30	1.57	0.79	1.57	0.79	1.57
160 5s TL V2	6.30	0.79	1.57	1.57	1.57	0.79
170 5s TL	6.69	1.57	1.18	1.18	1.18	1.57
170 5s TL V2	6.69	1.18	1.57	1.18	1.57	1.18
175 5s TL	6.89	1.38	1.38	1.38	1.38	1.38
180 5s TL	7.09	1.57	1.18	1.57	1.18	1.57
180 5s TL V2	7.09	1.18	1.57	1.57	1.57	1.18
190 5s TL	7.48	1.57	1.57	1.18	1.57	1.57
200 5s TL	7.87	1.57	1.57	1.57	1.57	1.57
160 5ss TL	6.30	2 x 1.18	1.57	2 x 1.18		

¹The layups are developed based on ANSI/APA PRG 320, using custom CLT Grade CV3M1. The layup designation refers to the panel thickness (in mm), the number of layers, a layup configuration identifier (“s” for standard perpendicular layers, “ss” for duplicate outer and/or central layers), and a panel orientation identifier (“TL” for major strength direction aligned with the long longitudinal panel dimension).

²Gross thickness of CLT panels.

³Actual thickness of lamination after planing. “||” denotes parallel to the major strength direction of the panel. “⊥” denotes perpendicular to the major strength direction of the panel.



TABLE 5 – KLH MASSIVHOLZPLATTEN CLT PANEL 5-PLY TT LAYUPS

CLT LAYUP ¹	PANEL THICKNESS t_p ² (in.)	LAMINATION ACTUAL THICKNESS ³ (in.)				
			⊥		⊥	
100 5s TT	3.94	0.79	0.79	0.79	0.79	0.79
110 5s TT	4.33	0.79	0.79	1.18	0.79	0.79
120 5s TT	4.72	1.18	0.79	0.79	0.79	1.18
120 5s TT V2	4.72	0.79	1.18	0.79	1.18	0.79
130 5s TT	5.12	1.18	0.79	1.18	0.79	1.18
140 5s TT	5.51	1.18	0.79	1.57	0.79	1.18
140 5s TT V2	5.51	0.79	1.57	0.79	1.57	0.79
140 5s TT V3	5.51	1.57	0.79	0.79	0.79	1.57
150 5s TT	5.91	1.18	1.18	1.18	1.18	1.18
150 5s TT V2	5.91	1.57	0.79	1.18	0.79	1.57
160 5s TT	6.30	1.57	0.79	1.57	0.79	1.57
175 5s TT	6.89	1.38	1.38	1.38	1.38	1.38
180 5s TT	7.09	1.57	1.18	1.57	1.18	1.57
200 5s TT	7.87	1.57	1.57	1.57	1.57	1.57

¹The layups are developed based on ANSI/APA PRG 320, using custom CLT Grade CV3M1. The layup designation refers to the panel thickness (in mm), the number of layers, a layup configuration identifier ("s" for standard perpendicular layers), and a panel orientation identifier ("TT" for major strength direction aligned with the short transverse panel dimension).

²Gross thickness of CLT panels.

³Actual thickness of lamination after planing. "||" denotes parallel to the major strength direction of the panel. "⊥" denotes perpendicular to the major strength direction of the panel.



TABLE 6 – KLH MASSIVHOLZPLATTEN CLT PANEL 7- AND 8-PLY LAYUPS

CLT LAYUP ¹	PANEL THICKNESS t_p ² (in.)	LAMINATION ACTUAL THICKNESS ³ (in.)						
			⊥		⊥		⊥	
140 7s TL	5.51	0.79	0.79	0.79	0.79	0.79	0.79	0.79
160 7s TL	6.30	0.79	1.18	0.79	0.79	0.79	1.18	0.79
180 7s TL	7.09	0.79	1.57	0.79	0.79	0.79	1.57	0.79
180 7s TL V2	7.09	1.18	0.79	1.18	0.79	1.18	0.79	1.18
200 7s TL	7.87	0.79	1.57	0.79	1.57	0.79	1.57	0.79
210 7s TL	8.27	1.18	1.18	1.18	1.18	1.18	1.18	1.18
220 7s TL	8.66	1.18	1.57	1.18	0.79	1.18	1.57	1.18
220 7s TL V2	8.66	1.57	0.79	1.57	0.79	1.57	0.79	1.57
230 7s TL	9.06	1.18	1.57	1.18	1.18	1.18	1.57	1.18
240 7s TL	9.45	1.18	1.57	1.18	1.57	1.18	1.57	1.18
245 7s TL	9.65	1.38	1.38	1.38	1.38	1.38	1.38	1.38
260 7s TL	10.24	1.57	1.57	1.18	1.57	1.18	1.57	1.57
180 7ss TL	7.09	2 x 1.18	0.79	0.79	0.79	2 x 1.18		
200 7ss TL	7.87	2 x 1.18	0.79	1.57	0.79	2 x 1.18		
210 7ss TL	8.27	2 x 1.18	1.18	1.18	1.18	2 x 1.18		
220 7ss TL	8.66	2 x 1.57	0.79	0.79	0.79	2 x 1.57		
220 7ss TL V2	8.66	2 x 1.18	1.18	1.57	1.18	2 x 1.18		
230 7ss TL	9.06	2 x 1.57	0.79	1.18	0.79	2 x 1.57		
240 7ss TL	9.45	2 x 1.57	0.79	1.57	0.79	2 x 1.57		
250 7ss TL	9.84	2 x 1.57	1.18	1.18	1.18	2 x 1.57		
260 7ss TL	10.24	2 x 1.57	1.18	1.57	1.18	2 x 1.57		
280 7ss TL	11.02	2 x 1.57	1.57	1.57	1.57	2 x 1.57		
180 7s TT	7.09	1.18	0.79	1.18	0.79	1.18	0.79	1.18
300 8ss TL	11.81	2 x 1.57	1.18	2 x 1.57	1.18	2 x 1.57		
320 8ss TL	12.60	2 x 1.57	1.57	2 x 1.57	1.57	2 x 1.57		

¹The layups are developed based on ANSI/APA PRG 320, using custom CLT Grade CV3M1. The layup designation refers to the panel thickness (in mm), the number of layers, a layup configuration identifier (“s” for standard perpendicular layers, “ss” for duplicate outer and/or central layers), and a panel orientation identifier (“TT” for major strength direction aligned with the short transverse panel dimension, “TL” for major strength direction aligned with the long longitudinal panel dimension).

²Gross thickness of CLT panels.

³Actual thickness of lamination after planing. “||” denotes parallel to the major strength direction of the panel. “⊥” denotes perpendicular to the major strength direction of the panel.



TABLE 7 – REFERENCE DESIGN VALUES FOR KLH MASSIVHOLZPLATTEN CLT PANEL 3-PLY LAYUPS¹

CLT LAYUP ²	Major Strength Direction					Minor Strength Direction				
	$F_b S_{eff,0}$ (lb-ft/ft)	$E I_{eff,0}$ ($\times 10^6$ lb-in ² /ft)	$G A_{eff,0}$ ($\times 10^6$ lb/ft)	$V_{s,0}$ (lb/ft)	$F_c A_0$ (lb/ft)	$F_b S_{eff,90}$ (lb-ft/ft)	$E I_{eff,90}$ ($\times 10^6$ lb-in ² /ft)	$G A_{eff,90}$ ($\times 10^6$ lb/ft)	$V_{s,90}$ (lb/ft)	$F_c A_{90}$ (lb/ft)
60 3s TL	743	20.3	0.34	1123	27,402	101	0.78	0.34	274	13,701
70 3s TL	969	30.9	0.37	1362	27,402	227	2.64	0.51	453	20,551
80 3s TL	1350	49.2	0.51	1453	41,102	101	0.78	0.37	231	13,701
80 3s TL V2	1205	43.9	0.40	1607	27,402	403	6.25	0.71	630	27,402
90 3s TL	1672	68.6	0.52	1684	41,102	227	2.64	0.52	410	20,551
100 3s TL	2124	96.9	0.71	1788	54,803	101	0.78	0.40	192	13,701
100 3s TL V2	2008	91.6	0.54	1922	41,102	403	6.25	0.68	590	27,402
105 3s TL	2276	109	0.60	1965	47,954	309	4.19	0.60	479	23,977
110 3s TL	2540	127	0.68	2013	54,803	227	2.64	0.54	367	20,551
120 3s TL	2973	163	0.69	2245	54,803	403	6.25	0.69	547	27,402
60 3s TT	743	20.3	0.34	1123	27,402	101	0.78	0.34	274	13,701
70 3s TT	969	30.9	0.37	1362	27,402	227	2.64	0.51	453	20,551
80 3s TT	1350	49.2	0.51	1453	41,102	101	0.78	0.37	231	13,701
80 3s TT V2	1205	43.9	0.40	1607	27,402	403	6.25	0.71	630	27,402
90 3s TT	1672	68.6	0.52	1684	41,102	227	2.64	0.52	410	20,551
100 3s TT	2008	91.6	0.54	1922	41,102	403	6.25	0.68	590	27,402
100 3s TT V2	2124	96.9	0.71	1788	54,803	101	0.78	0.40	192	13,701
105 3s TT	2276	109	0.60	1965	47,954	309	4.19	0.60	479	23,977
110 3s TT	2540	127	0.68	2013	54,803	227	2.64	0.54	367	20,551
120 3s TT	2973	163	0.69	2245	54,803	403	6.25	0.69	547	27,402

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

²The layups are developed based on ANSI/APA PRG 320, using custom CLT Grade CV3M1. The layup designation refers to the panel thickness (in mm), the number of layers, a layup configuration identifier ("s" for standard perpendicular layers), and a panel orientation identifier ("TT" for major strength direction aligned with the short transverse panel dimension, "TL" for major strength direction aligned with the long longitudinal panel dimension).



TABLE 8 – REFERENCE DESIGN VALUES FOR KLH MASSIVHOLZPLATTEN CLT PANEL 5-PLY TL LAYUPS¹

CLT LAYUP ²	Major Strength Direction					Minor Strength Direction				
	$F_b S_{eff,0}$ (lb-ft/ft)	$E I_{eff,0}$ (x10 ⁶ lb-in ² /ft)	$G A_{eff,0}$ (x10 ⁶ lb/ft)	$V_{s,0}$ (lb/ft)	$F_c A_0$ (lb/ft)	$F_b S_{eff,90}$ (lb-ft/ft)	$E I_{eff,90}$ (x10 ⁶ lb-in ² /ft)	$G A_{eff,90}$ (x10 ⁶ lb/ft)	$V_{s,90}$ (lb/ft)	$F_c A_{90}$ (lb/ft)
100 5s TL	1710	78	0.69	2004	41,102	874	20	0.69	1053	27,402
110 5s TL	1996	100	0.85	2158	47,953	1140	31	0.71	1286	27,402
120 5s TL	2724	149	0.85	2339	54,803	874	20	0.71	1010	27,402
120 5s TL V2	2214	121	0.74	2499	41,102	1588	49	1.03	1391	41,102
130 5s TL	3115	185	1.03	2514	61,653	1140	31	0.74	1239	27,402
130 5s TL V2	2501	148	0.88	2646	47,953	1967	69	1.02	1618	41,102
140 5s TL	3889	248	1.03	2669	68,504	874	20	0.74	963	27,402
140 5s TL V2	2730	174	0.81	2996	41,102	2499	97	1.42	1730	54,803
150 5s TL	4381	300	1.22	2854	75,354	1140	31	0.77	1189	27,402
150 5s TL V2	3849	263	1.03	3006	61,653	1967	69	1.03	1579	41,102
150 5s TL V3	3018	206	0.94	3138	47,953	2988	127	1.38	1953	54,803
160 5s TL	4901	358	1.42	3027	82,205	1417	44	0.81	1419	27,402
160 5s TL V2	3328	243	1.08	3258	54,803	3497	163	1.36	2182	54,803
160 5ss TL	5398	394	1.03	2905	82,205	403	6	0.74	462	27,402
170 5s TL	5333	413	1.19	3343	75,354	1967	69	1.05	1537	41,102
170 5s TL V2	4600	357	1.08	3501	61,653	2988	127	1.36	1917	54,803
175 5s TL	5239	418	1.20	3507	71,932	2678	109	1.20	1843	47,954
180 5s TL	5860	481	1.36	3515	82,205	2363	92	1.08	1766	41,102
180 5s TL V2	5023	412	1.22	3653	68,504	3497	163	1.36	2145	54,803
190 5s TL	6308	547	1.22	3837	75,354	2988	127	1.36	1879	54,803
200 5s TL	6842	624	1.37	4008	82,205	3497	163	1.37	2106	54,803

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

²The layups are developed based on ANSI/APA PRG 320, using custom CLT Grade CV3M1. The layup designation refers to the panel thickness (in mm), the number of layers, a layup configuration identifier (“s” for standard perpendicular layers, “ss” for duplicate outer and/or central layers), and a panel orientation identifier (“TL” for major strength direction aligned with the long longitudinal panel dimension).



TABLE 9 – REFERENCE DESIGN VALUES FOR KLH MASSIVHOLZPLATTEN CLT PANEL 5-PLY TT LAYUPS¹

CLT LAYUP ²	Major Strength Direction					Minor Strength Direction				
	F _b Seff,0 (lb-ft/ft)	E _{eff,0} (x10 ⁶ lb-in ² /ft)	GA _{eff,0} (x10 ⁶ lb/ft)	V _{s,0} (lb/ft)	F _c A ₀ (lb/ft)	F _b Seff,90 (lb-ft/ft)	E _{eff,90} (x10 ⁶ lb-in ² /ft)	GA _{eff,90} (x10 ⁶ lb/ft)	V _{s,90} (lb/ft)	F _c A ₉₀ (lb/ft)
100 5s TT	1710	78	0.69	2004	41,102	874	20	0.69	1053	27,402
110 5s TT	1996	100	0.85	2158	47,953	1140	31	0.71	1286	27,402
120 5s TT	2724	149	0.85	2339	54,803	874	20	0.71	1010	27,402
120 5s TT V2	2214	121	0.74	2499	41,102	1588	49	1.03	1391	41,102
130 5s TT	3115	185	1.03	2514	61,653	1140	31	0.74	1239	27,402
140 5s TT	3534	226	1.22	2676	68,504	1417	44	0.77	1473	27,402
140 5s TT V2	2730	174	0.81	2996	41,102	2499	97	1.42	1730	54,803
140 5s TT V3	3889	248	1.03	2669	41,102	874	20	0.74	963	54,803
150 5s TT	3849	263	1.03	3006	61,653	1967	69	1.03	1579	41,102
150 5s TT V2	4381	300	1.22	2854	75,354	1140	31	0.77	1189	27,402
160 5s TT	4901	358	1.42	3027	82,205	1417	44	0.81	1419	27,402
175 5s TT	5239	418	1.20	3507	71,932	2678	109	1.20	1843	47,954
180 5s TT	5860	481	1.36	3515	82,205	2363	92	1.08	1766	41,102
200 5s TT	6842	624	1.37	4008	82,205	3497	163	1.37	2106	54,803

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

²The layups are developed based on ANSI/APA PRG 320, using custom CLT Grade CV3M1. The layup designation refers to the panel thickness (in mm), the number of layers, a layup configuration identifier (“s” for standard perpendicular layers), and a panel orientation identifier (“TT” for major strength direction aligned with the short transverse panel dimension).

TABLE 10 – REFERENCE DESIGN VALUES FOR KLH MASSIVHOLZPLATTEN CLT PANEL 7- AND 8-PLY LAYUPS¹

CLT LAYUP ²	Major Strength Direction					Minor Strength Direction				
	F _b Seff,0 (lb-ft/ft)	E _{eff,0} (x10 ⁶ lb-in ² /ft)	GA _{eff,0} (x10 ⁶ lb/ft)	V _{s,0} (lb/ft)	F _c A ₀ (lb/ft)	F _b Seff,90 (lb-ft/ft)	E _{eff,90} (x10 ⁶ lb-in ² /ft)	GA _{eff,90} (x10 ⁶ lb/ft)	V _{s,90} (lb/ft)	F _c A ₉₀ (lb/ft)
140 7s TL	3025	193	1.03	2631	54,803	2012	78	1.03	1915	41,102
160 7s TL	3515	256	1.08	3080	54,803	3205	149	1.36	2265	54,803
180 7s TL	4021	330	1.14	3539	54,803	4575	248	1.73	2601	68,504
180 7s TL V2	5529	454	1.54	3317	82,205	2604	121	1.11	2336	41,102
180 7ss TL	6697	550	1.42	3328	95,905	874	20	0.81	864	27,402
200 7s TL	4789	437	1.21	3896	54,803	5766	358	2.13	2960	82,205
200 7ss TL	8100	739	1.85	3707	109,606	1417	44	0.89	1305	27,402
210 7s TL	6807	652	1.55	3946	82,205	4528	263	1.55	2873	61,653
210 7ss TL	8750	838	1.54	4003	102,756	1967	69	1.11	1444	41,102
220 7s TL	6983	701	1.56	4220	82,205	5681	352	1.71	3041	68,504
220 7s TL V2	8714	874	2.13	4005	109,606	3212	174	1.21	2741	41,102
220 7ss TL	10166	1020	1.85	3994	123,307	874	20	0.89	767	27,402
220 7ss TL V2	9482	951	1.73	4190	109,606	2363	92	1.14	1670	41,102
230 7s TL	7536	791	1.59	4393	82,205	6274	413	1.87	3226	75,354
230 7ss TL	11041	1158	2.08	4191	130,157	1140	31	0.93	975	27,402
240 7s TL	8110	888	1.62	4578	82,205	6895	481	2.04	3398	82,205
245 7s TL	9266	1035	1.80	4604	95,909	6163	418	1.80	3352	71,932
260 7s TL	10576	1254	1.76	5011	95,905	6895	481	2.04	3353	82,205

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

²The layups are developed based on ANSI/APA PRG 320, using custom CLT Grade CV3M1. The layup designation refers to the panel thickness (in mm), the number of layers, a layup configuration identifier ("s" for standard perpendicular layers, "ss" for duplicate outer and/or central layers), and a panel orientation identifier ("TL" for major strength direction aligned with the long longitudinal panel dimension).



TABLE 10 (CONTINUED) – REFERENCE DESIGN VALUES FOR KLH MASSIVHOLZPLATTEN CLT PANEL 7- AND 8-PLY LAYUPS¹

CLT LAYUP ²	Major Strength Direction					Minor Strength Direction				
	F _{bSeff,0} (lb-ft/ft)	E _{eff,0} (x10 ⁶ lb-in ² /ft)	G _{Aeff,0} (x10 ⁶ lb/ft)	V _{s,0} (lb/ft)	F _{cA0} (lb/ft)	F _{bSeff,90} (lb-ft/ft)	E _{eff,90} (x10 ⁶ lb-in ² /ft)	G _{Aeff,90} (x10 ⁶ lb/ft)	V _{s,90} (lb/ft)	F _{cA90} (lb/ft)
240 7ss TL	11945	1307	2.33	4380	137,008	1417	44	0.98	1189	27,402
250 7ss TL	12800	1459	1.92	4662	130,157	1967	69	1.18	1346	41,102
260 7ss TL	13728	1628	2.13	4855	137,008	2363	92	1.21	1567	41,102
280 7ss TL	15555	1986	2.05	5337	137,008	3497	163	1.48	1926	54,803
180 7s TT	5529	454	1.54	3317	82,205	2604	121	1.11	2336	41,102
300 8ss TL	17729	2426	3.01	5571	164,409	4046	220	1.38	2472	41,102
320 8ss TL	19605	2861	2.83	6055	164,409	5669	352	1.62	2839	54,803

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

²The layups are developed based on ANSI/APA PRG 320, using custom CLT Grade CV3M1. The layup designation refers to the panel thickness (in mm), the number of layers, a layup configuration identifier (“s” for standard perpendicular layers, “ss” for duplicate outer and/or central layers), and a panel orientation identifier (“TT” for major strength direction aligned with the short transverse panel dimension, “TL” for major strength direction aligned with the long longitudinal panel dimension).

TABLE 11 – REFERENCE DESIGN VALUES FOR IN-PLANE SHEAR FOR KLH MASSIVHOLZPLATTEN CLT PANELS¹

Layup ²	Thickness (in.)	Major Strength Direction		Minor Strength Direction	
		F _{v,e,0} ³ (psi)	F _{v,e,0t_p} ⁴ (lb/ft)	F _{v,e,90} ³ (psi)	F _{v,e,90t_p} ⁴ (lb/ft)
100 3S TL V2	3.92	254	11,900	284	13,300
100 3S TT	3.92	254	11,900	284	13,300
160 5S TL	6.25	307	23,000	216	16,200
160 5S TT	6.25	307	23,000	216	16,200

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

²The layups are developed based on ANSI/APA PRG 320, using custom CLT Grade CV3M1. The layup designation refers to the panel thickness (in mm), the number of layers, a layup configuration identifier (“s” for standard perpendicular layers, “ss” for duplicate outer and/or central layers), and a panel orientation identifier (“TT” for major strength direction aligned with the short transverse panel dimension, “TL” for major strength direction aligned with the long longitudinal panel dimension).

³The tabulated values are ASD reference edgewise shear stress oriented in the major (F_{v,e,0}) and minor (F_{v,e,90}) strength direction.

⁴The tabulated values are ASD reference edgewise shear capacity of the full CLT panel thickness oriented in the major (F_{v,e,0t_p}) and minor (F_{v,e,90t_p}) strength direction.



TABLE 12 – AXIAL COMPRESSION LOAD CAPACITY, P_c' (lb/ft), FOR KLH MASSIVHOLZPLATTEN CLT PANEL 3-PLY LAYUPS¹

CLT LAYUP ²	PANEL THICKNESS (in.)	WALL PANEL HEIGHT (FT)					
		8	10	12	14	16	18
60 3s TL	2.36	10,612					
70 3s TL	2.76	15,233	10,343				
80 3s TL	3.15	23,980	16,406	11,686			
80 3s TL V2	3.15	19,494	14,068	10,196			
90 3s TL	3.54	29,987	21,879	15,917	11,944		
100 3s TL	3.94	41,251	30,577	22,371	16,824	13,044	
100 3s TL V2	3.94	34,115	27,184	20,519	15,620	12,180	
105 3s TL	4.13	40,078	32,157	24,361	18,572	14,491	
110 3s TL	4.33	46,143	37,310	28,386	21,677	16,926	13,528
120 3s TL	4.72	48,988	42,700	34,347	26,883	21,223	17,058

¹The tabulated capacity, P_c' , values are intended for Allowable Stress Design (ASD) and are valid for the following conditions:
Where P_c' values are not given in the table, the slenderness ratio, l/d , exceeds 50. Equation C3.7.1-1 of the 2018 AWC NDS was used in the determination of P_c' values. No adjustments were applied for duration of load, end fixity, or eccentricity.

² The layups are developed based on ANSI/APA PRG 320, using custom CLT Grade CV3M1. The layup designation refers to the panel thickness (in mm), the number of layers, a layup configuration identifier (“s” for standard perpendicular layers), and a panel orientation identifier (“TL” for major strength direction aligned with the long longitudinal panel dimension).

TABLE 13 – AXIAL COMPRESSION LOAD CAPACITY, P_c' (lb/ft), FOR KLH MASSIVHOLZPLATTEN CLT PANEL 5-PLY LAYUPS¹

CLT LAYUP ²	PANEL THICKNESS (in.)	WALL PANEL HEIGHT (FT)								
		8	10	12	14	16	18	20	22	24
100 5s TL	3.94	31,900	24,085	17,745	13,382	10,388				
110 5s TL	4.33	38,747	30,137	22,484	17,038	13,257	10,576			
120 5s TL	4.72	48,078	40,832	32,103	24,858	19,530	15,659			
120 5s TL V2	4.72	36,604	31,737	25,399	19,830	15,638	12,562			
130 5s TL	5.12	55,161	48,143	38,775	30,368	23,981	19,277	15,782		
130 5s TL V2	5.12	43,073	37,808	30,627	24,057	19,022	15,301	12,531		
140 5s TL	5.51	63,145	57,602	48,918	39,525	31,667	25,638	21,073	17,582	
140 5s TL V2	5.51	38,483	35,920	31,646	26,334	21,425	17,478	14,425	12,065	
150 5s TL	5.91	70,205	65,062	56,625	46,617	37,705	30,670	25,273	21,118	17,880
150 5s TL V2	5.91	57,818	54,093	47,851	39,973	32,592	26,617	21,980	18,390	15,583
150 5s TL V3	5.91	44,954	42,035	37,150	31,007	25,269	20,631	17,035	14,251	12,075
160 5s TL	6.30	77,256	72,497	64,482	54,156	44,293	36,231	29,944	25,065	21,245
160 5s TL V2	6.30	51,504	48,331	42,988	36,104	29,529	24,154	19,963	16,710	14,164
170 5s TL	6.69	72,036	69,147	64,266	56,954	48,407	40,436	33,797	28,474	24,231
170 5s TL V2	6.69	59,098	56,915	53,252	47,670	40,888	34,348	28,797	24,304	20,704
175 5s TL	6.89	68,981	66,470	62,260	55,830	47,965	40,335	33,836	28,566	24,340
180 5s TL	7.09	78,872	76,047	71,317	64,073	55,150	46,431	38,976	32,918	28,054
180 5s TL V2	7.09	65,802	63,531	59,742	53,909	46,603	39,347	33,083	27,965	23,846
190 5s TL	7.48	73,019	71,188	68,258	63,674	57,240	49,808	42,648	36,433	31,262
200 5s TL	7.87	79,792	77,929	74,976	70,371	63,801	55,957	48,170	41,281	35,490

¹ The tabulated capacity, P_c' , values are intended for Allowable Stress Design (ASD) and are valid for the following conditions: Where P_c' values are not given in the table, the slenderness ratio, l/d , exceeds 50. Equation C3.7.1-1 of the 2018 AWC NDS was used in the determination of P_c' values. No adjustments were applied for duration of load, end fixity, or eccentricity.

² The layups are developed based on ANSI/APA PRG 320, using custom CLT Grade CV3M1. The layup designation refers to the panel thickness (in mm), the number of layers, a layup configuration identifier ("s" for standard perpendicular layers), and a panel orientation identifier ("TL" for major strength direction aligned with the long longitudinal panel dimension).

TABLE 14 – AXIAL COMPRESSION LOAD CAPACITY, P_c' (lb/ft), FOR KLH MASSIVHOLZPLATTEN CLT PANEL 7-PLY LAYUPS¹

CLT LAYUP ²	PANEL THICKNESS (in.)	WALL PANEL HEIGHT (FT)								
		8	10	12	14	16	18	20	22	24
140 7s TL	5.51	50,261	45,502	38,234	30,674	24,491	19,795	16,255	13,555	
160 7s TL	6.30	51,758	48,902	44,052	37,499	30,926	25,405	21,044	17,639	14,963
180 7s TL	7.09	52,609	50,756	47,660	42,905	37,003	31,193	26,204	22,140	18,873
180 7s TL V2	7.09	78,599	75,465	70,170	62,229	52,922	44,223	36,970	31,150	26,510
180 7ss TL	7.09	91,939	88,554	82,874	74,215	63,680	53,506	44,865	37,867	32,260
200 7s TL	7.87	53,252	52,065	50,198	47,294	43,114	38,018	32,853	28,219	24,294
200 7ss TL	7.87	105,913	102,949	98,132	90,593	80,346	69,117	58,753	49,977	42,777
210 7s TL	8.27	79,903	78,148	75,392	71,109	64,930	57,352	49,619	42,652	36,737
210 7ss TL	8.27	100,010	97,940	94,718	89,737	82,489	73,377	63,820	55,040	47,500
220 7s TL	8.66	80,085	78,502	76,054	72,287	66,777	59,728	52,173	45,119	39,004
220 7s TL V2	8.66	106,584	104,289	100,694	95,117	87,046	77,065	66,788	57,471	49,531
220 7ss TL	8.66	120,076	117,652	113,893	108,095	99,635	88,895	77,496	66,933	57,816
220 7ss TL V2	8.66	106,885	104,871	101,779	97,044	90,095	81,052	71,134	61,708	53,446
230 7s TL	9.06	80,365	79,036	77,034	74,015	69,572	63,566	56,567	49,547	43,174
230 7ss TL	9.06	127,029	124,730	121,223	115,876	108,014	97,647	86,057	74,864	64,954
240 7s TL	9.45	80,595	79,465	77,800	75,347	71,761	66,771	60,551	53,826	47,367
240 7ss TL	9.45	133,973	131,785	128,495	123,544	116,256	106,375	94,796	83,118	72,475
245 7s TL	9.65	94,041	92,730	90,801	87,961	83,812	78,034	70,816	62,990	55,455

¹ The tabulated capacity, P_c' , values are intended for Allowable Stress Design (ASD) and are valid for the following conditions: Where P_c' values are not given in the table, the slenderness ratio, l/d , exceeds 50. Equation C3.7.1-1 of the 2018 AWC NDS was used in the determination of P_c' values. No adjustments were applied for duration of load, end fixity, or eccentricity.

² The layups are developed based on ANSI/APA PRG 320, using custom CLT Grade CV3M1. The layup designation refers to the panel thickness (in mm), the number of layers, a layup configuration identifier ("s" for standard perpendicular layers, "ss" for duplicate outer and/or central layers), and a panel orientation identifier ("TL" for major strength direction aligned with the long longitudinal panel dimension).

**TABLE 15 – KLH MASSIVHOLZPLATTEN CLT PANEL LAYUPS BEARING FIRE RESISTANCE RATINGS**

CLT LAYUP ¹	PANEL USE	MAXIMUM LOAD ²	FIRE RESISTANCE
130 5s TL	Loaded Roof ³	27% of Design Load	60 min w/ hose
160 5s TL	Loaded Floor	71% of Design Load	60 min w/ hose
175 5s TL	Loaded Floor	36% of Design Load	120 min w/ hose
175 5s TL	Loaded Wall	12% of Design Load	120 min w/ hose
180 5s TL	Loaded Floor	53% of Design Load	120 min w/ hose

¹ The layups are developed based on ANSI/APA PRG 320, using custom CLT Grade CV3M1. The layup designation refers to the panel thickness (in mm), the number of layers, a layup configuration identifier (“s” for standard perpendicular layers), and a panel orientation identifier (“TL” for major strength direction aligned with the long longitudinal panel dimension).

² The tabulated percentages are based on ASD reference design values calculated in accordance with Chapter 10 of the NDS.

³ From bottom to top, the certified roof assembly consists of the 130 5s TL panel, Carlisle WIP 300HT self-adhesive rubberized asphalt underlayment, two layers of 2.2-inch polyisocyanurate insulation, a 1/4-inch Securock Gypsum-Fiber Roof Board, and a 60-mil TPO roofing membrane.