KLH®

MADE FOR BUILDING
BUILT FOR LIVING

STRUCTURAL PRE-ANALYSIS TABLES

IMPRINT

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KLH®

CONTENT

DESIGN GUIDE FOR USE IN CANADA

KLH® Cross Laminated Timber (CLT) panels are built up using layers of lumber, with successive layers arranged perpendicular to one another. These layers are glued together with environmentally friendly PUR adhesive to form strong, solid wood panels which can be used for floor, roof, and wall construction applications. CLT, as a wood product, is naturally green and sustainable, and structures can often be built more quickly than structures using other materials.

In addition, the total carbon footprint, including shipment by container from Europe, compares favorably with panels delivered by rail or truck, and our prices are very competitive. Panels are delivered to the job site sequenced and numbered for easy erection, with all openings and other details having been precisely made in the factory using CNC technology. Panels can be easily placed and connected with a relatively small crew using simple tools and standard, readily available fasteners. KLH®-CLT is manufactured in Austria of European spruce lumber. Our lumber supply is PEFC certified, with FSC® C119602 certified lumber available on request, and all products are manufactured to ANSI/APA PRG 320 standards.

KLH® was the first manufacturer in the world to produce CLT on a large-scale basis. KLH®-CLT has been used in over 35,000 projects worldwide.

This brochure is designed for engineers who are considering CLT or are currently designing a structure with CLT. Therefore, you'll find numerous technical topics, including design aids, material properties, and more. Other brochures are available, both in print and online, to introduce CLT to potential clients, architects, contractors, and developers.

After you've read through this brochure, we invite you to turn to KLH®, the industry leader in CLT. Please call or email us to begin a conversation about the many benefits offered by KLH®-CLT. We stand ready to provide design assistance, 3D modeling, cost estimates, and any other information and services that your design/construction team requires.

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01 PRODUCT DESCRIPTION

KLH® CROSS-LAMINATED TIMBER

KLH® cross-laminated timber is produced from layers of spruce lumber that are arranged crosswise to one another, with each layer glued to the adjacent layers under 0.6 N/mm² pressure to form large, solid wood elements (panels). The cross-wise arrangement of the longitudinal and transverse layers reduces swelling and shrinkage of the wood in the plane of the panel. Also, the arrangement of the layers results in strong elements capable of significant load carrying capacity over relatively long spans. The lumber used to produce KLH®-CLT panels is dried to a moisture content of 12% (+/- 2%) prior to producing the panels.

GLUING

Solvent- and formaldehyde-free PUR adhesive is used to glue the adjacent layers together. The glue is applied automatically and uniformly over the entire adhered surfaces, thus achieving a high level of adhesion under the high manufacturing pressure. All lumber comprising the laminations is carefully sorted prior to manufacturing of the built-up panels.

CNC CUTTING

Precise factory cutting according to specific design requirements takes place using state-of-the-art CNC technology. Cutting accuracy is generally +/- 2 mm, resulting in extremely precise finished panels with minimal waste. In addition to panel overall dimensions, window, door, and other openings can easily be prefabricated prior to delivery to the job site.

SURFACE QUALITY

KLH®-CLT panels are available in non-visible (NVQ), industrial visible (IVQ), and domestic visible (DVQ) surface qualities. The DVQ level includes gluing the sides of the boards together in the outer most, visible surface lamination. IVQ and DVQ surfaces are sanded.

ASSEMBLY

CLT panels can be erected quickly and efficiently by relatively small crews using simple tools and connectors. A crane is used to raise the panels into position. Holes, channels, or other surface features, such as those required for utility lines or electrical wiring, can be cut on site, or prefabricated. Erection consists of connecting wall, floor, and roof panels together to quickly build a fully enclosed structure. Of course, CLT panels also work particularly well in combination with wood post-and-beam frameworks.

Lifting of KLH® TL panel

Erection Murray Grove in London I UK

TECHNICAL DESCRIPTION

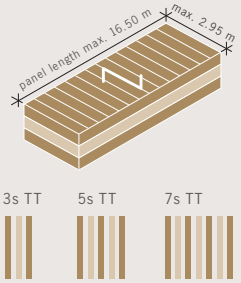
PRODUCT	Solid wood panels with crosswise glued laminations
PRODUCT NAME	KLH®-CLT
USES	Structural elements for walls, floors, and roofs
WOOD TYPE	Spruce (other wood species on request)
PANEL BUILD-UPS	3-, 5-, 7-, and 8-laminations
LAMINATIONS	Lamination thicknesses 20 - 40 mm Sorted for quality and finger-jointed
PANEL GRADE	CV3M1
GLUE	Formaldehyde-free PUR adhesive
LAMINATION PRESSURE	0,6 N/mm², minimum
MOISTURE CONTENT	12% (+/- 2%) at delivery
MAXIMUM DIMENSIONS	Length 16.5 m / width 2.95 m / thickness 0.5 m
INVOICING WIDTHS	2.40 / 2.50 / 2.73 / 2.95 m
SURFACE QUALITIES	Non-visible (NVQ) / Industrial visible (IVQ) / Domestic visible (DVQ)
WEIGHT	For structural calculations, 5.5 kN/m³ Shipping weight, 500 kg/m³
DIMENSIONAL CHANGE WITH MOISTURE CONTENT	In-plane: 0.02% per 1% change in moisture content Out-of-plane: 0.24% per 1% change in moisture content
NOMINAL CHAR RATE	38 mm/hr.
EFFECTIVE CHAR DEPTH	48 mm after 1 hour All lamination thicknesses = 35 mm
FIRE DESIGN	According to CLT Handbook, Canada Ed.
FLAME SPREAD INDEX	Classification B
CERTIFICATION	ANSI/APA PRG 320-2018

02 STANDARD PANEL TYPES AND STRUCTURES

INVOICING WIDTHS: 2.40 / 2.50 / 2.73 / 2.95 M
MAXIMUM DIMENSIONS: LENGTH 16.5 / WIDTH 2.95 / THICKNESS 0.5 M

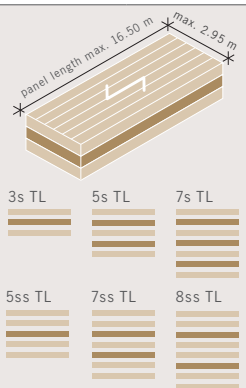
FOR THE WALL
Covering layer in the transverse panel direction TT

Thickness	Panel Type	Lamination Thickness in CLT Layup						
(mm)	[TT/TL]	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)
60	3s TT	20	20	20				
70	3s TT	20	30	20				
80	3s TT	30	20	30				
80	3s TT V2	20	40	20				
90	3s TT	30	30	30				
100	3s TT	30	40	30				
100	3s TT V2	40	20	40				
105	3s TT	35	35	35				
110	3s TT	40	30	40				
120	3s TT	40	40	40				
100	5s TT	20	20	20	20	20		
110	5s TT	20	20	30	20	20		
120	5s TT	30	20	20	20	30		
120	5s TT V2	20	30	20	30	20		
130	5s TT	30	20	30	20	30		
140	5s TT	30	20	40	20	30		
140	5s TT V2	20	40	20	40	20		
140	5s TT V3	40	20	20	20	40		
150	5s TT	30	30	30	30	30		
150	5s TT V2	40	20	30	20	40		
160	5s TT	40	20	40	20	40		
175	5s TT	35	35	35	35	35		
180	5s TT	40	30	40	30	40		
200	5s TT	40	40	40	40	40		
180	7s TT	30	20	30	20	30	20	30



FOR FLOOR AND ROOF
Covering layer in the longitudinal panel direction TL

60	3s TL	20	20	20				
70	3s TL	20	30	20				
80	3s TL	30	20	30				
80	3s TL V2	20	40	20				
90	3s TL	30	30	30				
100	3s TL	40	20	40				
100	3s TL V2	30	40	30				
105	3s TL	35	35	35				
110	3s TL	40	30	40				
120	3s TL	40	40	40				



STANDARD PANELS AND STRUCTURES

FOR FLOOR AND ROOF
Covering layer in the longitudinal panel direction TL

Thickness	Panel Type	Lamination Thickness in CLT Layup							
(mm)	[TT/TL]	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)
100	5s TL	20	20	20	20	20			
110	5s TL	20	20	30	20	20			
120	5s TL	30	20	20	20	30			
120	5s TL V2	20	30	20	30	20			
130	5s TL	30	20	30	20	30			
130	5s TL V2	20	30	30	30	20			
140	5s TL	40	20	20	20	40			
140	5s TL V2	20	40	20	40	20			
150	5s TL	40	20	30	20	40			
150	5s TL V2	30	30	30	30	30			
150	5s TL V3	20	40	30	40	20			
160	5s TL	40	20	40	20	40			
160	5s TL V2	20	40	40	40	20			
170	5s TL	40	30	30	30	40			
170	5s TL V2	30	40	30	40	30			
175	5s TL	35	35	35	35	35			
180	5s TL	40	30	40	30	40			
180	5s TL V2	30	40	40	40	30			
190	5s TL	40	40	30	40	40			
200	5s TL	40	40	40	40	40			
160	5ss TL	30	30	40	30	30			
140	7s TL	20	20	20	20	20	20	20	
160	7s TL	20	30	20	20	20	30	20	
180	7s TL	20	40	20	20	20	40	20	
180	7s TL V2	30	20	30	20	30	20	30	
200	7s TL	20	40	20	40	20	40	20	
210	7s TL	30	30	30	30	30	30	30	
220	7s TL	30	40	30	20	30	40	30	
220	7s TL V2	40	20	40	20	40	20	40	
230	7s TL	30	40	30	30	30	40	30	
240	7s TL	30	40	30	40	30	40	30	
245	7s TL	35	35	35	35	35	35	35	
260	7s TL	40	40	30	40	30	40	40	
180	7ss TL	30	30	20	20	20	30	30	
200	7ss TL	30	30	20	40	20	30	30	
210	7ss TL	30	30	30	30	30	30	30	
220	7ss TL	40	40	20	20	20	40	40	
220	7ss TL V2	30	30	30	40	30	30	30	
230	7ss TL	40	40	20	30	20	40	40	
240	7ss TL	40	40	20	40	20	40	40	
250	7ss TL	40	40	30	30	30	40	40	
260	7ss TL	40	40	30	40	30	40	40	
280	7ss TL	40	40	40	40	40	40	40	
300	8ss TL	40	40	30	40	40	30	40	40
320	8ss TL	40	40	40	40	40	40	40	40

03 LIMIT STATES DESIGN (LSD) CAPACITIES (for use in Canada)

3.1 TT PANELS

Table 3.1.1 Specified Strengths and Modulus of Elasticity for Lumber Laminations Used in KLH®-CLT (for use in Canada)

CLT Grade	Major Strength Direction						Minor Strength Direction					
	$f_{b,0}$ (MPa)	E_0 (MPa)	$f_{t,0}$ (MPa)	$f_{c,0}$ (MPa)	$f_{v,0}$ (MPa)	$f_{s,0}$ (MPa)	$f_{b,90}$ (MPa)	E_{90} (MPa)	$f_{t,90}$ (MPa)	$f_{c,90}$ (MPa)	$f_{v,90}$ (MPa)	$f_{s,90}$ (MPa)
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

Table 3.1.2 Unfactored Limit States Design (LSD) Capacities for KLH®-CLT (for use in Canada)

CLT Grade	Layup	Panel Thick-ness (mm)	Lamination thickness (mm) in CLT layup							Major Strength Direction					Minor Strength Direction				
			=	⊢	=	⊢	=	⊢	=	$F_bS_{eff,0}$ (10^6 N-mm/m)	$EI_{eff,0}$ (10^9 N-mm²/m)	$GA_{eff,0}$ (10^6 N/m)	$M_{r,0}$ (kN-m/m)	$V_{r,0}$ (kN/m)	$F_bS_{eff,90}$ (10^6 N-mm/m)	$EI_{eff,90}$ (10^9 N-mm²/m)	$GA_{eff,90}$ (10^6 N/m)	$M_{r,90}$ (kN-m/m)	$V_{r,90}$ (kN/m)
CV3M1	60 3s TT	60	20	20	20					6	191	5.0	4.8	21.6	0.7	7.3	5.0	0.6	7.2
CV3M1	70 3s TT	70	20	30	20					8	290	5.4	6.2	25.2	1.6	24.8	7.5	1.5	10.8
CV3M1	80 3s TT	80	30	20	30					11	462	7.5	8.7	28.8	0.7	7.3	5.4	0.6	7.2
CV3M1	80 3s TT V2	80	20	40	20					10	413	5.9	7.7	28.8	2.9	58.7	10.3	2.6	14.4
CV3M1	90 3s TT	90	30	30	30					14	644	7.5	10.8	32.4	1.6	24.8	7.5	1.5	10.8
CV3M1	100 3s TT	100	40	20	40					18	910	10.3	13.7	36.0	0.7	7.3	5.9	0.6	7.2
CV3M1	100 3s TT V2	100	30	40	30					17	860	7.8	12.9	36.0	2.9	58.7	9.9	2.6	14.4
CV3M1	105 3s TT	105	35	35	35					19	1023	8.8	14.6	37.8	2.2	39.3	8.8	2.0	12.6
CV3M1	110 3s TT	110	40	30	40					21	1196	9.9	16.3	39.6	1.6	24.8	7.8	1.5	10.8
CV3M1	120 3s TT	120	40	40	40					25	1527	10.0	19.1	43.2	2.9	58.7	10.0	2.6	14.4
CV3M1	100 5s TT	100	20	20	20	20	20			14	732	10.0	11.0	36.0	6.2	191	10.0	5.6	21.6
CV3M1	110 5s TT	110	20	20	30	20	20			17	940	12.4	12.8	39.6	8.1	290	10.3	7.3	25.2
CV3M1	120 5s TT	120	30	20	20	20	30			23	1400	12.4	17.5	43.2	6.2	191	10.3	5.6	21.6
CV3M1	120 5s TT V2	120	20	30	20	30	20			19	1137	10.7	14.2	43.2	11.3	462	14.9	10.2	28.8
CV3M1	130 5s TT	130	30	20	30	20	30			26	1734	14.9	20.0	46.8	8.1	290	10.7	7.3	25.2
CV3M1	140 5s TT	140	30	20	40	20	30			30	2118	17.7	22.7	50.4	10.1	413	11.2	9.1	28.8
CV3M1	140 5s TT V2	140	20	40	20	40	20			23	1636	11.8	17.6	50.4	17.9	910	20.6	16.1	36.0
CV3M1	140 5s TT V3	140	40	20	20	20	40			33	2331	14.9	25.0	50.4	6.2	191	10.7	5.6	21.6
CV3M1	150 5s TT	150	30	30	30	30	30			32	2472	15.0	24.8	54.0	14.1	644	15.0	12.7	32.4
CV3M1	150 5s TT V2	150	40	20	30	20	40			37	2814	17.7	28.2	54.0	8.1	290	11.2	7.3	25.2
CV3M1	160 5s TT	160	40	20	40	20	40			41	3358	20.6	31.5	57.6	10.1	413	11.8	9.1	28.8
CV3M1	175 5s TT	175	35	35	35	35	35			44	3925	17.5	33.7	63.0	19.1	1023	17.5	17.2	37.8
CV3M1	180 5s TT	180	40	30	40	30	40			49	4517	19.8	37.7	64.8	16.9	860	15.7	15.2	36.0
CV3M1	200 5s TT	200	40	40	40	40	40			58	5859	20.0	44.0	72.0	25.0	1527	20.0	22.5	43.2
CV3M1	180 7s TT	180	30	20	30	20	30	20	30	46	4261	22.4	35.6	64.8	18.6	1137	16.1	16.8	43.2

* See notes on pg. 10

3.2 TL PANELS

Table 3.2.1 Specified Strengths and Modulus of Elasticity for Lumber Laminations Used in KLH®-CLT (for use in Canada)

CLT Grade	Major Strength Direction						Minor Strength Direction					
	$f_{b,0}$ (MPa)	E_0 (MPa)	$f_{t,0}$ (MPa)	$f_{c,0}$ (MPa)	$f_{v,0}$ (MPa)	$f_{s,0}$ (MPa)	$f_{b,90}$ (MPa)	E_{90} (MPa)	$f_{t,90}$ (MPa)	$f_{c,90}$ (MPa)	$f_{v,90}$ (MPa)	$f_{s,90}$ (MPa)
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

Table 3.2.2 Unfactored Limit States Design (LSD) Bending Resistances for KLH®-CLT (for use in Canada)

CLT Grade	Layup	Panel Thick-ness (mm)	Lamination thickness (mm) in CLT layup							Major Strength Direction					Minor Strength Direction				
			=	⊦	=	⊦	=	⊦	=	$F_bS_{eff,0}$ (10^6 N-mm/m)	$EI_{eff,0}$ (10^9 N-mm²/m)	$GA_{eff,0}$ (10^6 N/m)	$M_{r,0}$ (kN-m/m)	$V_{r,0}$ (kN/m)	$F_bS_{eff,90}$ (10^6 N-mm/m)	$EI_{eff,90}$ (10^9 N-mm²/m)	$GA_{eff,90}$ (10^6 N/m)	$M_{r,90}$ (kN-m/m)	$V_{r,90}$ (kN/m)
CV3M1	60 3s TL	60	20	20	20					6	191	5.0	4.8	21.6	0.7	7.3	5.0	0.6	7.2
CV3M1	70 3s TL	70	20	30	20					8	290	5.4	6.2	25.2	1.6	24.8	7.5	1.5	10.8
CV3M1	80 3s TL	80	30	20	30					11	462	7.5	8.7	28.8	0.7	7.3	5.4	0.6	7.2
CV3M1	80 3s TL V2	80	20	40	20					10	413	5.9	7.7	28.8	2.9	58.7	10.3	2.6	14.4
CV3M1	90 3s TL	90	30	30	30					14	644	7.5	10.8	32.4	1.6	24.8	7.5	1.5	10.8
CV3M1	100 3s TL	100	40	20	40					18	910	10.3	13.7	36.0	0.7	7.3	5.9	0.6	7.2
CV3M1	100 3s TL V2	100	30	40	30					17	860	7.8	12.9	36.0	2.9	58.7	9.9	2.6	14.4
CV3M1	105 3s TL	105	35	35	35					19	1023	8.8	14.6	37.8	2.2	39.3	8.8	2.0	12.6
CV3M1	110 3s TL	110	40	30	40					21	1196	9.9	16.3	39.6	1.6	24.8	7.8	1.5	10.8
CV3M1	120 3s TL	120	40	40	40					25	1527	10.0	19.1	43.2	2.9	58.7	10.0	2.6	14.4
CV3M1	100 5s TL	100	20	20	20	20	20			14	732	10.0	11.0	36.0	6.2	191	10.0	5.6	21.6
CV3M1	110 5s TL	110	20	20	30	20	20			17	940	12.4	12.8	39.6	8.1	290	10.3	7.3	25.2
CV3M1	120 5s TL	120	30	20	20	20	30			23	1400	12.4	17.5	43.2	6.2	191	10.3	5.6	21.6
CV3M1	120 5s TL V2	120	20	30	20	30	20			19	1137	10.7	14.2	43.2	11.3	462	14.9	10.2	28.8
CV3M1	130 5s TL	130	30	20	30	20	30			26	1734	14.9	20.0	46.8	8.1	290	10.7	7.3	25.2
CV3M1	130 5s TL V2	130	20	30	30	30	20			21	1392	12.8	16.1	46.8	14.1	644	14.9	12.7	32.4
CV3M1	140 5s TL	140	40	20	20	20	40			33	2331	14.9	25.0	50.4	6.2	191	10.7	5.6	21.6
CV3M1	140 5s TL V2	140	20	40	20	40	20			23	1636	11.8	17.6	50.4	17.9	910	20.6	16.1	36.0
CV3M1	150 5s TL	150	40	20	30	20	40			37	2814	17.7	28.2	54.0	8.1	290	11.2	7.3	25.2
CV3M1	150 5s TL V2	150	30	30	30	30	30			32	2472	15.0	24.8	54.0	14.1	644	15.0	12.7	32.4
CV3M1	150 5s TL V3	150	20	40	30	40	20			25	1938	13.7	19.4	54.0	21.4	1196	20.0	19.2	39.6
CV3M1	160 5s TL	160	40	20	40	20	40			41	3358	20.6	31.5	57.6	10.1	413	11.8	9.1	28.8
CV3M1	160 5s TL V2	160	20	40	40	40	20			28	2280	15.7	21.4	57.6	25.0	1527	19.8	22.5	43.2

* See notes on pg. 10

FLEXURAL DESIGN CAPACITIES

Table 3.2.2. Unfactored Limit States Design (LSD) Bending Resistances for KLH®-CLT (for use in Canada) (continued)

CLT Grade	Layup #	Thick-ness (mm)	Lamination thickness (mm) in CLT layup							Major Strength Direction					Minor Strength Direction				
			=	⊢	=	⊢	=	⊢	=	$F_bS_{eff,0}$ (10^6 N-mm/m)	$EI_{eff,0}$ (10^9 N-mm²/m)	$GA_{eff,0}$ (10^6 N/m)	$M_{r,0}$ (kN-m/m)	$V_{r,0}$ (kN/m)	$F_bS_{eff,90}$ (10^6 N-mm/m)	$EI_{eff,90}$ (10^9 N-mm²/m)	$GA_{eff,90}$ (10^6 N/m)	$M_{r,90}$ (kN-m/m)	$V_{r,90}$ (kN/m)
CV3M1	170 5s TL	170	40	30	30	30	40			45	3882	17.3	34.3	61.2	14.1	644.3	15.3	12.7	32.4
CV3M1	170 5s TL V2	170	30	40	30	40	30			39	3348	15.7	29.6	61.2	21.4	1196	19.8	19.2	39.6
CV3M1	175 5s TL	175	35	35	35	35	35			44	3925	17.5	33.7	63.0	19.1	1023	17.5	17.2	37.8
CV3M1	180 5s TL	180	40	30	40	30	40			49	4517	19.8	37.7	64.8	16.9	860	15.7	15.2	36.0
CV3M1	180 5s TL V2	180	30	40	40	40	30			42	3872	17.8	32.3	64.8	25.0	1527	19.8	22.5	43.2
CV3M1	190 5s TL	190	40	40	30	40	40			53	5132	17.8	40.6	68.4	21.4	1196	19.8	19.2	39.6
CV3M1	200 5s TL	200	40	40	40	40	40			58	5859	20.0	44.0	72.0	25.0	1527	20.0	22.5	43.2
CV3M1	140 7s TL	140	20	20	20	20	20	20	20	25	1814	15.0	19.5	50.4	14.4	732	15.0	12.9	36.0
CV3M1	160 7s TL	160	20	30	20	20	20	30	20	30	2408	15.7	22.6	57.6	22.9	1400	19.8	20.6	43.2
CV3M1	180 7s TL	180	20	40	20	20	20	40	20	34	3099	16.6	25.9	64.8	32.7	2331	25.1	29.4	50.4
CV3M1	180 7s TL V2	180	30	20	30	20	30	20	30	46	4261	22.4	35.6	64.8	18.6	1137	16.1	16.8	43.2
CV3M1	200 7s TL	200	20	40	20	40	20	40	20	40	4101	17.7	30.8	72.0	41.2	3358	30.9	37.1	57.6
CV3M1	210 7s TL	210	30	30	30	30	30	30	30	57	6121	22.5	43.8	75.6	32.4	2472	22.5	29.1	54.0
CV3M1	220 7s TL	220	30	40	30	20	30	40	30	59	6578	22.8	44.9	79.2	40.6	3308	24.8	36.5	57.6
CV3M1	220 7s TL V2	220	40	20	40	20	40	20	40	73	8208	30.9	56.0	79.2	23.0	1636	17.7	20.7	50.4
CV3M1	230 7s TL	230	30	40	30	30	30	40	30	63	7422	23.1	48.5	82.8	44.8	3882	27.2	40.4	61.2
CV3M1	240 7s TL	240	30	40	30	40	30	40	30	68	8334	23.5	52.2	86.4	49.3	4517	29.7	44.3	64.8
CV3M1	245 7s TL	245	35	35	35	35	35	35	35	78	9719	26.3	59.6	88.2	44.0	3925	26.3	39.6	63.0
CV3M1	260 7s TL	260	40	40	30	40	30	40	40	89	11773	25.6	68.0	93.6	49.3	4517	29.7	44.3	64.8
CV3M1	160 5ss TL	160	60	40	60					45	3698	14.9	34.7	57.6	2.9	59	10.7	2.6	14.4

* See notes on pg. 10

FLEXURAL DESIGN CAPACITIES

Table 3.2.2 Unfactored Limit States Design (LSD) Bending Resistances for KLH®-CLT (for use in Canada) (continued)

CLT Grade	Layup #	Thick-ness (mm)	Lamination thickness (mm) in CLT layup							Major Strength Direction					Minor Strength Direction				
			=	⊦	=	⊦	=	⊦	=	$F_bS_{eff,0}$ (10^6 N-mm/m)	$EI_{eff,0}$ (10^9 N-mm^2/m)	$GA_{eff,0}$ (10^6 N/m)	$M_{r,0}$ (kN-m/m)	$V_{r,0}$ (kN/m)	$F_bS_{eff,90}$ (10^6 N-mm/m)	$EI_{eff,90}$ (10^9 N-mm^2/m)	$GA_{eff,90}$ (10^6 N/m)	$M_{r,90}$ (kN-m/m)	$V_{r,90}$ (kN/m)
CV3M1	180 7ss TL	180	60	20	20	20	60			56	5162	20.6	43.1	64.8	6.2	191	11.8	5.6	21.6
CV3M1	200 7ss TL	200	60	20	40	20	60			68	6936	27.0	52.1	72.0	10.1	413	13.0	9.1	28.8
CV3M1	210 7ss TL	210	60	30	30	30	60			74	7867	22.4	56.3	75.6	14.1	644	16.1	12.7	32.4
CV3M1	220 7ss TL	220	80	20	20	20	80			85	9576	27.0	65.4	79.2	6.2	191	13.0	5.6	21.6
CV3M1	220 7ss TL V2	220	60	30	40	30	60			80	8931	25.1	61.0	79.2	16.9	860	16.6	15.2	36.0
CV3M1	230 7ss TL	230	80	20	30	20	80			93	10873	30.3	71.0	82.8	8.1	290	13.6	7.3	25.2
CV3M1	240 7ss TL	240	80	20	40	20	80			100	12275	33.8	76.8	86.4	10.1	413	14.2	9.1	28.8
CV3M1	250 7ss TL	250	80	30	30	30	80			108	13701	28.0	82.3	90.0	14.1	644	17.1	12.7	32.4
CV3M1	260 7ss TL	260	80	30	40	30	80			115	15282	30.9	88.3	93.6	16.9	860	17.7	15.2	36.0
CV3M1	280 7ss TL	280	80	40	40	40	80			131	18648	29.9	100.0	100.8	25.0	1527	21.5	22.5	43.2
CV3M1	300 8ss TL	300	80	30	80	30	80			149	22772	43.8	114.0	108.0	28.9	2062	20.0	26.0	50.4
CV3M1	320 8ss TL	320	80	40	80	40	80			165	26862	41.3	126.1	115.2	40.5	3301	23.6	36.5	57.6

1 Tabulated values are based on the following standard conditions. EOR to verify factors.
   a Dry service (K_{Sb} = K_{Sv} = 1.0)
   b Standard-term duration load (K_D = 1.0)
   c Untreated lumber (K_T = 1.0)
2 Tabulated values are unfactored Limit States design values and are not permitted to be increased for the lumber size adjustment factor in accordance with CSA O86. Tabulated Mr and Vr values have been factored by Φ=0.9. The major strength axis bending resistance values, $M_{r,0,}$ have been adjusted by $K_{rb,y}$=0.85, per CSA O86.
3 The CV3M1 grade uses spruce lumber in both major and minor strength directions.
4 The specified strength in rolling shear, $f_{s,}$ is taken as approximately 1/3 of the specified strength in shear, $f_{v,}$ for the corresponding species combination.
5 The transverse modulus of elasticity, $E_{90,}$ is estimated as E/30.
6 The shear modulus, G, is estimated as E/16.
7 The rolling shear modulus, $G_{90,}$ is estimated as G/10.
8 For Imperial: 1 mm = 0.0394 in.; 1 m = 3.28 ft; 1 N = 0.2248 lbf

3.3 IN-PLANE SHEAR STRENGTH

Table 3. LSD Specified Edgewise Shear Strength of KLH®-CLT
(For Use in Canada)

Grade	Layup (lams.)	Thickness, t_p (mm)	$f_{v,e,0}$ (MPa)	$f_{v,e,90}$ (MPa)
CV3M1	3	60-120	3.5	4.1
CV3M1	5	100-200	3.9	3.4
CV3M1	7	140-280	3.9	3.4
CV3M1	8	300-320	3.9	3.4

- $f_{v,e,0}$ and $f_{v,e,90}$ are the in-plane shear stresses in the major and minor strength direction, respectively
- Strength values shall be applied to the CLT thickness, t_p.
- 3 lamination values based on test results from 100 3s TL V2 panels.
- 5, 7, and 8 lamination values based on test results from 160 5s TL panels.
- Testing performed at the Composite Materials and Engineering Center at Washington State University, Pullman, WA, an IAS Accredited Testing Laboratory (TL-246).
- Strength values determined by multiplying characteristic strength obtained from testing by 0.96 as per ANSI/APA PRG 320 Cl. 8.5.6.2

Supermarket roof in Graz I Austria

04 KLH® FLOOR PANELS - SINGLE SPAN

4.1 FLOORS WITHOUT CONCRETE TOPPING

according to CSA O86-14

		LIVE LOAD (SINGLE SPAN)														
		1.9 kPa RESIDENTIAL			2.4 kPa OFFICE / CLASSROOM			3.6 kPa MECHANICAL ROOM			4.8 kPa ASSEMBLY			7.2 kPa LIBRARY		
Layup	Mass	Strength	Deflec-tion	Vibra-tion	Strength	Deflec-tion	Vibra-tion	Strength	Deflec-tion	Vibra-tion	Strength	Deflec-tion	Vibra-tion	Strength	Deflec-tion	Vibra-tion
	kg/m²	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
60 3s TL	33.6	2911	2313	2453	2696	2230	2453	2327	1968	-	2077	1774	-	1752	1528	-
70 3s TL	39.2	3300	2634	2720	3059	2541	2720	2645	2257	-	2363	2034	-	1995	1751	-
80 3s TL	44.8	3865	3064	3062	3586	2959	3062	3106	2652	3062	2778	2393	-	2348	2065	-
80 3s TL V2	44.8	3651	2934	2963	3388	2833	2963	2934	2535	-	2624	2284	-	2218	1965	-
90 3s TL	50.4	4270	3386	3325	3967	3272	3325	3441	2952	3325	3080	2661	-	2606	2293	-
100 3s TL	56	4779	3789	3628	4443	3665	3628	3860	3333	3628	3459	3010	-	2930	2600	-
100 3s TL V2	56	4647	3693	3570	4320	3571	3570	3753	3243	3570	3363	2923	-	2848	2516	-
105 3s TL	58.8	4928	3905	3732	4585	3777	3732	3986	3444	3732	3573	3105	-	3028	2675	-
110 3s TL	61.6	5188	4106	3883	4828	3973	3883	4201	3637	3883	3768	3281	-	3195	2829	-
120 3s TL	67.2	5573	4412	4125	5192	4272	4125	4524	3936	4125	4061	3548	-	3447	3057	-
100 5s TL	56	4288	3528	3407	3987	3413	3407	3464	3105	3407	3104	2804	-	2629	2423	-
110 5s TL	61.6	4599	3816	3621	4280	3694	3621	3724	3386	3621	3340	3060	-	2832	2648	-
120 5s TL	67.2	5335	4313	4022	4970	4177	4022	4331	3853	4022	3888	3479	-	3300	3007	-
120 5s TL V2	67.2	4810	4018	3787	4480	3891	3787	3904	3588	3787	3505	3238	-	2975	2796	-
130 5s TL	72.8	5666	4610	4239	5283	4469	4239	4610	4151	4239	4142	3751	-	3519	3246	-
130 5s TL V2	72.8	5077	4277	3977	4733	4145	3977	4130	3849	3977	3711	3477	-	3153	3006	-
140 5s TL	78.4	6288	5041	4578	5868	4889	4578	5127	4569	4578	4611	4127	4578	3922	3567	-
140 5s TL V2	78.4	5268	4467	4131	4916	4331	4131	4296	4046	4131	3863	3652	-	3286	3152	-
150 5s TL	84	6629	5343	4795	6192	5185	4795	5418	4867	4795	4876	4409	4795	4151	3815	-
150 5s TL V2	84	6213	5103	4618	5803	4951	4618	5078	4646	4618	4570	4206	-	3891	3635	-
150 5s TL V3	84	5502	4704	4304	5139	4564	4304	4497	4283	4304	4047	3877	-	3446	3350	-
160 5s TL	89.6	6965	5639	5008	6511	5476	5008	5705	5147	5008	5139	4689	5008	4380	4062	-
160 5s TL V2	89.6	5740	4942	4476	5366	4798	4476	4701	4508	4476	4235	4104	-	3609	3550	-
170 5s TL	95.2	7217	5839	5185	6753	5683	5185	5925	5343	5185	5341	4888	5185	4556	4224	-
170 5s TL V2	95.2	6703	5551	4968	6272	5402	4968	5502	5078	4968	4961	4644	-	4232	4011	-
175 5s TL	98	7130	5832	5184	6674	5687	5184	5859	5350	5184	5284	4907	5184	4510	4241	-
180 5s TL	100.8	7517	6093	5381	7039	5953	5381	6184	5604	5381	5580	5155	5381	4764	4459	-
180 5s TL V2	100.8	6960	5780	5146	6517	5647	5146	5725	5315	5146	5166	4888	5146	4411	4225	-
190 5s TL	106.4	7750	6274	5548	7262	6151	5548	6388	5793	5548	5768	5352	5548	4930	4621	-
200 5s TL	112	8020	6509	5730	7521	6403	5730	6624	6037	5730	5986	5608	5730	5121	4847	-

* See notes on pg. 13

4.1 FLOORS WITHOUT CONCRETE TOPPING (continued)

		LIVE LOAD (SINGLE SPAN)														
		1.9 kPa RESIDENTIAL			2.4 kPa OFFICE / CLASSROOM			3.6 kPa MECHANICAL ROOM			4.8 kPa ASSEMBLY			7.2 kPa LIBRARY		
Layup	Mass	Strength	Deflec-tion	Vibra-tion	Strength	Deflec-tion	Vibra-tion	Strength	Deflec-tion	Vibra-tion	Strength	Deflec-tion	Vibra-tion	Strength	Deflec-tion	Vibra-tion
	kg/m²	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
140 7s TL	78.4	5546	4645	4256	5176	4505	4256	4522	4212	4256	4067	3806	-	3459	3293	-
160 7s TL	89.6	5898	5030	4548	5514	4884	4548	4831	4588	4548	4352	4177	-	3709	3612	-
180 7s TL	100.8	6227	5368	4824	5830	5244	4824	5122	4936	4824	4622	4539	-	3946	3924	-
180 7s TL V2	100.8	7302	5995	5291	6837	5858	5291	6006	5516	5291	5420	5078	5291	4628	4398	-
200 7s TL	112	6710	5779	5167	6292	5685	5167	5542	5360	5167	5008	4978	-	4284	-	-
210 7s TL	117.6	7950	6562	5769	7461	6477	5769	6579	6114	5769	5950	5710	5769	5095	4940	-
220 7s TL	123.2	8002	6661	5858	7516	6595	5858	6635	6230	5858	6006	5846	5858	5147	5057	-
220 7s TL V2	123.2	8939	7207	6247	8396	7137	6247	7412	6746	6247	6709	6335	6247	5750	5492	-
230 7s TL	128.8	8263	6871	6035	7766	6823	6035	6864	6450	6035	6218	6081	6035	5334	5259	-
240 7s TL	134.4	8520	7077	6209	8014	7048	6209	7091	6668	6209	6428	6316	6209	5519	5461	-
245 7s TL	137.2	9080	7430	6476	8543	7411	6476	7564	7015	6476	6859	6661	6476	5892	5763	-
260 7s TL	145.6	9616	7807	6798	9056	7807	6798	8032	7406	6798	7291	7065	6798	6271	6120	-
160 5ss TL	89.6	7309	5776	5150	6833	5606	5150	5987	5264	5150	5393	4786	5150	4596	4129	-
180 7ss TL	100.8	8036	6370	5594	7525	6223	5594	6611	5859	5594	5965	5389	5594	5093	4661	-
200 7ss TL	112	8726	6924	6017	8184	6813	6017	7207	6428	6017	6514	5977	6017	5572	5177	-
210 7ss TL	117.6	9013	7119	6205	8459	7027	6205	7459	6631	6205	6746	6190	6205	5777	5351	-
220 7ss TL	123.2	9656	7557	6532	9069	7482	6532	8006	7069	6532	7247	6635	6532	6211	5742	-
220 7ss TL V2	123.2	9325	7375	6402	8758	7302	6402	7732	6898	6402	6999	6473	6402	5998	5599	-
230 7ss TL	128.8	10002	7830	6741	9400	7776	6741	8309	7354	6741	7526	6937	6741	6456	6008	-
240 7ss TL	134.4	10341	8097	6947	9726	8065	6947	8606	7634	6947	7802	7236	6947	6699	6271	-
250 7ss TL	140	10641	8287	7137	10015	8276	7137	8872	7836	7137	8049	7457	7137	6917	6448	-
260 7ss TL	145.6	10955	8539	7332	10318	8539	7332	9151	8104	7332	8307	7733	7332	7145	6705	-
280 7ss TL	156.8	11528	8960	7699	10871	8960	7699	9662	8556	7699	8784	8171	7699	7568	7134	-
300 8ss TL	168	12169	9511	8091	11490	9511	8091	10234	9143	8091	9316	8748	8091	8041	7718	-
320 8ss TL	179.2	12657	9881	8422	11964	9881	8422	10678	9551	8422	9734	9144	8422	8414	8123	-

1 The following modification factors were used for calculations: $K_{D,std\ term} = K_H = K_S = K_T = 1.0$; $K_{D,longterm} = 0.65$
2 Span table includes panel self-weight plus 1.0kPa for miscellaneous dead load allowance.
3 CLT is NOT an isotropic material. Presented values to be used for bending of panels in the major strength axis.
4 Span tables are intended for preliminary design only – responsible engineer shall ensure that the panel meets all the requirements set forth in local Building Code for the project.
5 Tabulated deflection spans are the governing case of L/240, L/480, L360 which corresponds to total, live and long term serviceability limits, respectively. Engineer to ensure limits are appropriate.
6 Instantaneous elastic deflection due to long-term loads has been adjusted by a creep factor of 2.0 for dry service condition.
7 Panels assumed to be simply supported with pin support conditions spanning from center lines of support.
8 Nominal density of spruce = 5.5 kN/m³ per ONORM B 1991-1-1:2011
9 Spans based on one-way, strong axis bending only
10 Fire ratings not considered
11 Indicates governing span case
12 - Indicates panel is strength (ULS) governed, therefore deflection and/or vibration is not a governing factor.

4.2 FLOORS WITH 38 MM GYPSUM TOPPING

according to CSA O86-14

		LIVE LOAD (SINGLE SPAN)														
		1.9 kPa RESIDENTIAL			2.4 kPa OFFICE / CLASSROOM			3.6 kPa MECHANICAL ROOM			4.8 kPa ASSEMBLY			7.2 kPa LIBRARY		
Layup	Mass	Strength	Deflec-tion	Vibra-tion	Strength	Deflec-tion	Vibra-tion	Strength	Deflec-tion	Vibra-tion	Strength	Deflec-tion	Vibra-tion	Strength	Deflec-tion	Vibra-tion
	kg/m²	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
60 3s TL	33.6	2673	2100	2453	2504	2052	2453	2200	1930	-	1985	1774	-	1696	1528	-
70 3s TL	39.2	3034	2386	2720	2843	2340	2720	2502	2202	-	2259	2034	-	1931	1751	-
80 3s TL	44.8	3557	2776	3062	3336	2732	3062	2939	2575	-	2657	2393	-	2273	2065	-
80 3s TL V2	44.8	3361	2655	2963	3152	2613	2963	2777	2461	-	2510	2284	-	2148	1965	-
90 3s TL	50.4	3935	3062	3325	3693	3024	3325	3258	2851	-	2947	2661	-	2524	2293	-
100 3s TL	56	4408	3426	3628	4141	3394	3628	3657	3206	3628	3310	3010	-	2838	2600	-
100 3s TL V2	56	4286	3335	3570	4026	3303	3570	3555	3117	-	3219	2923	-	2759	2516	-
105 3s TL	58.8	4549	3525	3732	4274	3497	3732	3777	3302	3732	3420	3105	-	2933	2675	-
110 3s TL	61.6	4791	3707	3883	4503	3683	3883	3981	3479	3883	3607	3281	-	3095	2829	-
120 3s TL	67.2	5152	3977	4125	4846	3963	4125	4289	3746	4125	3889	3548	-	3340	3057	-
100 5s TL	56	3955	3191	3407	3715	3161	3407	3281	2986	-	2970	2804	-	2546	2423	-
110 5s TL	61.6	4247	3450	3621	3992	3428	3621	3530	3242	-	3198	3060	-	2744	2648	-
120 5s TL	67.2	4932	3893	4022	4639	3879	4022	4106	3670	4022	3723	3479	-	3197	3007	-
120 5s TL V2	67.2	4446	3625	3787	4182	3613	3787	3702	3417	-	3356	3238	-	2882	2796	-
130 5s TL	72.8	5243	4160	4239	4935	4157	4239	4373	3937	4239	3968	3751	-	3410	3246	-
130 5s TL V2	72.8	4697	3858	3977	4422	3855	3977	3918	3650	-	3555	3477	-	3056	3006	-
140 5s TL	78.4	5824	4543	4578	5485	4543	4578	4866	4313	4578	4418	4115	-	3801	3567	-
140 5s TL V2	78.4	4879	4023	4131	4596	4023	4131	4077	3818	-	3702	3641	-	3185	3152	-
150 5s TL	84	6146	4813	4795	5792	4813	4795	5144	4586	4795	4674	4379	-	4024	3815	-
150 5s TL V2	84	5760	4594	4618	5429	4594	4618	4821	4376	4618	4381	4177	-	3772	3635	-
150 5s TL V3	84	5101	4235	4304	4808	4235	4304	4270	4033	-	3879	3850	-	3340	-	-
160 5s TL	89.6	6463	5078	5008	6096	5078	5008	5419	4854	5008	4927	4639	-	4246	4062	-
160 5s TL V2	89.6	5326	4447	4476	5023	4447	4476	4466	4250	-	4060	4059	-	3499	-	-
170 5s TL	95.2	6703	5258	5185	6326	5258	5185	5630	5040	5185	5123	4816	-	4418	4224	-
170 5s TL V2	95.2	6226	4997	4968	5875	4997	4968	5229	4789	4968	4758	4575	-	4103	4011	-
175 5s TL	98	6625	5259	5184	6254	5259	5184	5569	5048	5184	5069	4825	-	4374	4241	-
180 5s TL	100.8	6988	5503	5381	6599	5503	5381	5879	5291	5381	5353	5060	-	4620	4459	-
180 5s TL V2	100.8	6470	5219	5146	6110	5219	5146	5443	5017	5146	4956	4797	-	4278	4225	-
190 5s TL	106.4	7210	5675	5548	6813	5675	5548	6076	5470	5548	5535	5231	-	4782	4621	-
200 5s TL	112	7468	5903	5730	7060	5903	5730	6303	5707	5730	5746	5461	5730	4968	4847	-

* See notes on pg. 15

4.2 FLOORS WITH 38 MM GYPSUM TOPPING (continued)

		LIVE LOAD (SINGLE SPAN)														
		1.9 kPa RESIDENTIAL			2.4 kPa OFFICE / CLASSROOM			3.6 kPa MECHANICAL ROOM			4.8 kPa ASSEMBLY			7.2 kPa LIBRARY		
Layup	Mass	Strength	Deflec-tion	Vibra-tion	Strength	Deflec-tion	Vibra-tion	Strength	Deflec-tion	Vibra-tion	Strength	Deflec-tion	Vibra-tion	Strength	Deflec-tion	Vibra-tion
	kg/m²	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
140 7s TL	78.4	5137	4188	4256	4838	4188	4256	4292	3977	4256	3897	3795	-	3353	3293	-
160 7s TL	89.6	5473	4526	4548	5162	4526	4548	4589	4325	4548	4173	4131	-	3596	-	-
180 7s TL	100.8	5788	4847	4824	5466	4847	4824	4870	4659	4824	4434	-	-	3827	-	-
180 7s TL V2	100.8	6788	5418	5291	6410	5418	5291	5710	5211	5291	5199	4984	-	4488	4398	-
200 7s TL	112	6248	5241	5167	5907	5241	5167	5273	5066	5167	4807	-	-	4157	-	-
210 7s TL	117.6	7409	5967	5769	7009	5967	5769	6263	5785	5769	5713	5540	-	4944	4940	-
220 7s TL	123.2	7464	6068	5858	7065	6068	5858	6319	5899	5858	5768	5652	-	4995	-	-
220 7s TL V2	123.2	8338	6573	6247	7892	6573	6247	7058	6392	6247	6443	6127	6247	5580	5492	-
230 7s TL	128.8	7713	6271	6035	7304	6271	6035	6539	6111	6035	5973	5857	-	5177	-	-
240 7s TL	134.4	7959	6471	6209	7542	6471	6209	6758	6321	6209	6177	6061	-	5358	-	-
245 7s TL	137.2	8485	6801	6476	8042	6801	6476	7210	6653	6476	6592	6381	6476	5720	-	-
260 7s TL	145.6	8996	7161	6798	8533	7161	6798	7660	7029	6798	7010	6744	6798	6090	-	-
160 5ss TL	89.6	6783	5191	5150	6397	5191	5150	5687	4958	5150	5171	4733	5150	4456	4129	-
180 7ss TL	100.8	7471	5753	5594	7054	5753	5594	6285	5531	5594	5722	5289	5594	4939	4661	-
200 7ss TL	112	8126	6287	6017	7682	6287	6017	6858	6081	6017	6252	5823	6017	5406	5177	-
210 7ss TL	117.6	8400	6471	6205	7946	6471	6205	7100	6273	6205	6477	6006	6205	5605	5351	-
220 7ss TL	123.2	9006	6886	6532	8524	6886	6532	7624	6694	6532	6960	6415	6532	6027	5742	-
220 7ss TL V2	123.2	8697	6719	6402	8232	6719	6402	7363	6532	6402	6721	6258	6402	5821	5599	-
230 7ss TL	128.8	9336	7151	6741	8841	7151	6741	7915	6970	6741	7230	6683	6741	6266	6008	-
240 7ss TL	134.4	9660	7411	6947	9153	7411	6947	8202	7242	6947	7497	6948	6947	6502	6271	-
250 7ss TL	140	9948	7590	7137	9430	7590	7137	8458	7433	7137	7736	7130	7137	6715	6448	-
260 7ss TL	145.6	10249	7837	7332	9721	7837	7332	8727	7693	7332	7986	7384	7332	6938	6705	-
280 7ss TL	156.8	10761	8245	7699	10254	8245	7699	9222	8129	7699	8449	7807	7699	7351	7134	-
300 8ss TL	168	11296	8790	8091	10850	8790	8091	9774	8705	8091	8965	8373	8091	7812	7718	-
320 8ss TL	179.2	11687	9153	8422	11310	9153	8422	10205	9100	8422	9371	8757	8422	8177	8123	-

1 The following modification factors were used for calculations: $K_{D,std\ term} = K_H = K_S = K_T = 1.0$; $K_{D,longterm} = 0.65$
2 Span table includes panel self-weight, 0.70 kPa for 38mm gypcrete topping, plus 1.0kPa for miscellaneous dead load allowance.
3 CLT is NOT an isotropic material. Presented values to be used for bending of panels in the major strength axis.
4 Span tables are intended for preliminary design only – responsible engineer shall ensure that the panel meets all the requirements set forth in local Building Code for the project.
5 Tabulated deflection spans is the governing case of L/240, L/480, L360 which corresponds to total, live and long term serviceability limits, respectively. Engineer to ensure limits are appropriate.
6 Instantaneous elastic deflection due to long-term loads has been adjusted by a creep factor of 2.0 for dry service condition.
7 Panels assumed to be simply supported with pin support conditions spanning from center lines of support.
8 Nominal density of spruce = 5.5 kN/m³ per ONORM B 1991-1-1:2011
9 Spans based on one-way, strong axis bending only
10 Fire ratings not considered
11 Indicates governing span case
12 - Indicates panel is strength (ULS) governed, therefore deflection and/or vibration is not a governing factor.

4.3 FLOORS WITH 50 MM CONCRETE TOPPING

according to CSA O86-14

		LIVE LOAD (SINGLE SPAN)														
		1.9 kPa RESIDENTIAL			2.4 kPa OFFICE / CLASSROOM			3.6 kPa MECHANICAL ROOM			4.8 kPa ASSEMBLY			7.2 kPa LIBRARY		
Layup	Mass	Strength	Deflec-tion	Vibra-tion	Strength	Deflec-tion	Vibra-tion	Strength	Deflec-tion	Vibra-tion	Strength	Deflec-tion	Vibra-tion	Strength	Deflec-tion	Vibra-tion
	kg/m²	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
60 3s TL	33.6	2490	1937	2453	2383	1937	-	2117	1845	-	1924	1760	-	1657	1528	-
70 3s TL	39.2	2828	2205	2720	2708	2205	-	2408	2106	-	2190	2010	-	1887	1751	-
80 3s TL	44.8	3318	2572	3062	3179	2572	3062	2830	2466	-	2575	2355	-	2221	2065	-
80 3s TL V2	44.8	3135	2457	2963	3004	2457	2963	2674	2354	-	2433	2247	-	2099	1965	-
90 3s TL	50.4	3673	2840	3325	3521	2840	3325	3138	2730	-	2857	2608	-	2467	2293	-
100 3s TL	56	4117	3186	3628	3949	3186	3628	3523	3073	-	3210	2940	-	2774	2600	-
100 3s TL V2	56	4003	3098	3570	3840	3098	3570	3425	2986	-	3121	2853	-	2697	2516	-
105 3s TL	58.8	4250	3278	3732	4078	3278	3732	3639	3164	-	3317	3025	-	2867	2675	-
110 3s TL	61.6	4477	3450	3883	4297	3450	3883	3837	3336	-	3499	3191	-	3025	2829	-
120 3s TL	67.2	4817	3706	4125	4627	3706	4125	4135	3593	4125	3773	3437	-	3265	3057	-
100 5s TL	56	3694	2968	3407	3544	2968	3407	3161	2863	-	2880	2739	-	2489	2423	-
110 5s TL	61.6	3969	3215	3621	3810	3215	3621	3401	3111	-	3101	2978	-	2682	2648	-
120 5s TL	67.2	4612	3632	4022	4429	3632	4022	3958	3523	-	3612	3373	-	3126	3007	-
120 5s TL V2	67.2	4157	3381	3787	3993	3381	3787	3568	3279	-	3256	3139	-	2818	2796	-
130 5s TL	72.8	4905	3888	4239	4714	3888	4239	4217	3782	-	3850	3624	-	3335	3246	-
130 5s TL V2	72.8	4395	3605	3977	4223	3605	3977	3778	3506	-	3449	3358	-	2988	-	-
140 5s TL	78.4	5452	4250	4578	5242	4250	4578	4694	4143	4578	4288	3971	-	3717	3567	-
140 5s TL V2	78.4	4568	3762	4131	4392	3762	4131	3932	3667	-	3593	3513	-	3114	-	-
150 5s TL	84	5757	4510	4795	5537	4510	4795	4963	4409	4795	4537	4229	-	3936	3815	-
150 5s TL V2	84	5395	4303	4618	5190	4303	4618	4652	4206	4618	4252	4032	-	3689	3635	-
150 5s TL V3	84	4778	3967	4304	4596	3967	4304	4119	3877	-	3766	3717	-	3267	-	-
160 5s TL	89.6	6057	4766	5008	5830	4766	5008	5230	4670	5008	4784	4482	-	4153	4062	-
160 5s TL V2	89.6	4992	4171	4476	4804	4171	4476	4310	4087	-	3942	3921	-	3423	-	-
170 5s TL	95.2	6286	4937	5185	6053	4937	5185	5435	4848	5185	4974	4652	-	4322	4224	-
170 5s TL V2	95.2	5838	4691	4968	5622	4691	4968	5048	4606	4968	4620	4420	-	4014	4011	-
175 5s TL	98	6214	4941	5184	5986	4941	5184	5377	4857	5184	4923	4662	-	4279	4241	-
180 5s TL	100.8	6556	5175	5381	6317	5175	5381	5677	5094	5381	5199	4891	-	4520	4459	-
180 5s TL V2	100.8	6070	4907	5146	5848	4907	5146	5256	4829	5146	4813	4636	-	4185	-	-
190 5s TL	106.4	6768	5339	5548	6524	5339	5548	5868	5266	5548	5377	5056	-	4679	4621	-
200 5s TL	112	7014	5561	5730	6764	5561	5730	6089	5497	5730	5583	5282	-	4862	4847	-

* See notes on pg. 17

4.3 FLOORS WITH 50 MM CONCRETE TOPPING (continued)

		LIVE LOAD (SINGLE SPAN)														
		1.9 kPa RESIDENTIAL			2.4 kPa OFFICE / CLASSROOM			3.6 kPa MECHANICAL ROOM			4.8 kPa ASSEMBLY			7.2 kPa LIBRARY		
Layup	Mass	Strength	Deflec-tion	Vibra-tion	Strength	Deflec-tion	Vibra-tion	Strength	Deflec-tion	Vibra-tion	Strength	Deflec-tion	Vibra-tion	Strength	Deflec-tion	Vibra-tion
	kg/m²	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
140 7s TL	78.4	4809	3919	4256	4623	3919	4256	4140	3822	-	3782	3664	-	3279	-	-
160 7s TL	89.6	5129	4245	4548	4937	4245	4548	4429	4160	-	4051	3990	-	3517	-	-
180 7s TL	100.8	5431	4557	4824	5232	4557	4824	4702	4485	-	4306	4306	-	3744	-	-
180 7s TL V2	100.8	6368	5097	5291	6136	5097	5291	5514	5017	5291	5050	4819	-	4391	-	-
200 7s TL	112	5868	4937	5167	5659	4937	5167	5094	4880	-	4671	-	-	4067	-	-
210 7s TL	117.6	6962	5629	5769	6717	5629	5769	6052	5576	5769	5552	5361	-	4838	-	-
220 7s TL	123.2	7017	5730	5858	6773	5730	5858	6108	5688	5858	5606	5470	-	4889	-	-
220 7s TL V2	123.2	7838	6211	6247	7566	6211	6247	6823	6166	6247	6263	5933	6247	5461	-	-
230 7s TL	128.8	7234	5926	6035	7006	5926	6035	6322	5894	6035	5807	5670	-	5067	-	-
240 7s TL	134.4	7445	6121	6209	7236	6121	6209	6536	6099	6209	6006	5869	-	5245	-	-
245 7s TL	137.2	7926	6438	6476	7718	6438	6476	6973	6421	6476	6410	6181	-	5600	-	-
260 7s TL	145.6	8371	6785	6798	8193	6785	6798	7411	6785	6798	6818	6535	6798	5962	-	-
160 5ss TL	89.6	6357	4866	5150	6118	4866	5150	5489	4766	5150	5020	4570	-	4359	4129	-
180 7ss TL	100.8	7009	5410	5594	6753	5410	5594	6069	5325	5594	5558	5113	-	4832	4661	-
200 7ss TL	112	7631	5928	6017	7360	5928	6017	6625	5860	6017	6075	5634	6017	5290	5177	-
210 7ss TL	117.6	7893	6103	6205	7615	6103	6205	6861	6045	6205	6294	5810	6205	5485	5351	-
220 7ss TL	123.2	8466	6504	6532	8172	6504	6532	7369	6456	6532	6764	6209	6532	5899	5742	-
220 7ss TL V2	123.2	8176	6345	6402	7892	6345	6402	7117	6298	6402	6533	6057	6402	5697	5599	-
230 7ss TL	128.8	8756	6762	6741	8480	6762	6741	7653	6725	6741	7028	6472	6741	6134	6008	-
240 7ss TL	134.4	9035	7015	6947	8782	7015	6947	7932	6991	6947	7289	6731	6947	6365	6271	-
250 7ss TL	140	9280	7186	7137	9052	7186	7137	8182	7174	7137	7523	6906	7137	6574	6448	-
260 7ss TL	145.6	9537	7428	7332	9334	7428	7332	8444	7428	7332	7768	7156	7332	6793	6703	-
280 7ss TL	156.8	10001	7825	7699	9853	7825	7699	8927	7825	7699	8220	7568	7699	7199	7093	-
300 8ss TL	168	10522	8363	8091	10432	8363	8091	9465	8363	8091	8726	8126	8091	7651	7634	-
320 8ss TL	179.2	10910	8718	8422	10882	8718	8422	9887	8718	8422	9124	8502	8422	8011	7992	-

1 The following modification factors were used for calculations: $K_{D,std\ term} = K_H = K_S = K_T = 1.0$; $K_{D,longterm} = 0.65$
2 Span table includes panel self-weight, 1.20 kPa for 50mm concrete topping, plus 1.0kPa for miscellaneous dead load allowance.
3 CLT is NOT an isotropic material. Presented values to be used for bending of panels in the major strength axis.
4 Span tables are intended for preliminary design only – responsible engineer shall ensure that the panel meets all the requirements set forth in local Building Code for the project.
5 Tabulated deflection spans is the governing case of L/240, L/480, L360 which corresponds to total, live and long term serviceability limits, respectively. Engineer to ensure limits are appropriate.
6 Instantaneous elastic deflection due to long-term loads has been adjusted by a creep factor of 2.0 for dry service condition.
7 Panels assumed to be simply supported with pin support conditions spanning from center lines of support.
8 Nominal density of spruce = 5.5 kN/m³ per ONORM B 1991-1-1:2011
9 Spans based on one-way, strong axis bending only
10 Fire ratings not considered
11 Indicates governing span case
12 - Indicates panel is strength (ULS) governed, therefore deflection and/or vibration is not a governing factor.

05 KLH® FLOOR PANELS - DOUBLE SPAN

5.1 FLOORS WITHOUT CONCRETE TOPPING

according to CSA O86-14

		LIVE LOAD (DOUBLE SPAN)														
		1.9 kPa RESIDENTIAL			2.4 kPa OFFICE / CLASSROOM			3.6 kPa MECHANICAL ROOM			4.8 kPa ASSEMBLY			7.2 kPa LIBRARY		
Layup	Mass	Strength	Deflec-tion	Vibra-tion	Strength	Deflec-tion	Vibra-tion	Strength	Deflec-tion	Vibra-tion	Strength	Deflec-tion	Vibra-tion	Strength	Deflec-tion	Vibra-tion
	kg/m²	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
60 3s TL	33.6	2911	-	-	2696	-	-	2327	-	-	2077	-	-	1752	-	-
70 3s TL	39.2	3300	-	3264	3059	-	-	2645	-	-	2363	-	-	1995	-	-
80 3s TL	44.8	3865	-	3675	3586	-	-	3106	-	-	2778	-	-	2348	-	-
80 3s TL V2	44.8	3651	-	3556	3388	-	-	2934	-	-	2624	-	-	2218	-	-
90 3s TL	50.4	4270	-	3990	3967	-	-	3441	-	-	3080	-	-	2606	-	-
100 3s TL	56	4779	-	4354	4443	-	4354	3860	-	-	3459	-	-	2930	-	-
100 3s TL V2	56	4647	-	4283	4320	-	4283	3753	-	-	3363	-	-	2848	-	-
105 3s TL	58.8	4928	-	4479	4585	-	4479	3986	-	-	3573	-	-	3028	-	-
110 3s TL	61.6	5188	-	4660	4828	-	4660	4201	-	-	3768	-	-	3195	-	-
120 3s TL	67.2	5573	-	4950	5192	-	4950	4524	-	-	4061	-	-	3447	-	-
100 5s TL	56	4288	-	4088	3987	-	-	3464	-	-	3104	-	-	2629	-	-
110 5s TL	61.6	4599	-	4346	4280	-	-	3724	-	-	3340	-	-	2832	-	-
120 5s TL	67.2	5335	-	4827	4970	-	4827	4331	-	-	3888	-	-	3300	-	-
120 5s TL V2	67.2	4810	-	4545	4480	-	-	3904	-	-	3505	-	-	2975	-	-
130 5s TL	72.8	5666	-	5087	5283	-	5087	4610	-	-	4142	-	-	3519	-	-
130 5s TL V2	72.8	5077	-	4773	4733	-	-	4130	-	-	3711	-	-	3153	-	-
140 5s TL	78.4	6288	-	5493	5868	-	5493	5127	-	-	4611	-	-	3922	-	-
140 5s TL V2	78.4	5268	-	4958	4916	-	-	4296	-	-	3863	-	-	3286	-	-
150 5s TL	84	6629	-	5754	6192	-	5754	5418	-	-	4876	-	-	4151	-	-
150 5s TL V2	84	6213	-	5542	5803	-	5542	5078	-	-	4570	-	-	3891	-	-
150 5s TL V3	84	5502	-	5164	5139	-	-	4497	-	-	4047	-	-	3446	-	-
160 5s TL	89.6	6965	-	6010	6511	-	6010	5705	-	-	5139	-	-	4380	-	-
160 5s TL V2	89.6	5740	-	5372	5366	-	-	4701	-	-	4235	-	-	3609	-	-
170 5s TL	95.2	7217	-	6222	6753	-	6222	5925	-	-	5341	-	-	4556	-	-
170 5s TL V2	95.2	6703	-	5961	6272	-	5961	5502	-	-	4961	-	-	4232	-	-
175 5s TL	98	7130	-	6221	6674	-	6221	5859	-	-	5284	-	-	4510	-	-
180 5s TL	100.8	7517	-	6457	7039	-	6457	6184	-	-	5580	-	-	4764	-	-
180 5s TL V2	100.8	6960	-	6175	6517	-	6175	5725	-	-	5166	-	-	4411	-	-
190 5s TL	106.4	7750	-	6658	7262	-	6658	6388	-	-	5768	-	-	4930	-	-
200 5s TL	112	8020	-	6876	7521	-	6876	6624	-	-	5986	-	-	5121	-	-

* See notes on pg. 19

5.1 FLOORS WITHOUT CONCRETE TOPPING (continued)

		LIVE LOAD (DOUBLE SPAN)														
		1.9 kPa RESIDENTIAL			2.4 kPa OFFICE / CLASSROOM			3.6 kPa MECHANICAL ROOM			4.8 kPa ASSEMBLY			7.2 kPa LIBRARY		
Layup	Mass	Strength	Deflec-tion	Vibra-tion	Strength	Deflec-tion	Vibra-tion	Strength	Deflec-tion	Vibra-tion	Strength	Deflec-tion	Vibra-tion	Strength	Deflec-tion	Vibra-tion
	kg/m²	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
140 7s TL	78.4	5546	-	5108	5176	-	5108	4522	-	-	4067	-	-	3459	-	-
160 7s TL	89.6	5898	-	5457	5514	-	5457	4831	-	-	4352	-	-	3709	-	-
180 7s TL	100.8	6227	-	5789	5830	-	5789	5122	-	-	4622	-	-	3946	-	-
180 7s TL V2	100.8	7302	-	6349	6837	-	6349	6006	-	-	5420	-	-	4628	-	-
200 7s TL	112	6710	-	6200	6292	-	6200	5542	-	-	5008	-	-	4284	-	-
210 7s TL	117.6	7950	-	6923	7461	-	6923	6579	-	-	5950	-	-	5095	-	-
220 7s TL	123.2	8002	-	7030	7516	-	7030	6635	-	-	6006	-	-	5147	-	-
220 7s TL V2	123.2	8939	-	7496	8396	-	7496	7412	-	-	6709	-	-	5750	-	-
230 7s TL	128.8	8263	-	7242	7766	-	7242	6864	-	-	6218	-	-	5334	-	-
240 7s TL	134.4	8520	-	7451	8014	-	7451	7091	-	-	6428	-	-	5519	-	-
245 7s TL	137.2	9080	-	7772	8543	-	7772	7564	-	-	6859	-	-	5892	-	-
260 7s TL	145.6	9616	-	8157	9056	-	8157	8032	-	-	7291	-	-	6271	-	-
160 5ss TL	89.6	7309	-	6180	6833	-	6180	5987	-	-	5393	-	-	4596	-	-
180 7ss TL	100.8	8036	-	6712	7525	-	6712	6611	-	-	5965	-	-	5093	-	-
200 7ss TL	112	8726	-	7221	8184	-	7221	7207	-	-	6514	-	-	5572	-	-
210 7ss TL	117.6	9013	-	7446	8459	-	7446	7459	-	7446	6746	-	-	5777	-	-
220 7ss TL	123.2	9656	-	7839	9069	-	7839	8006	-	7839	7247	-	-	6211	-	-
220 7ss TL V2	123.2	9325	-	7682	8758	-	7682	7732	-	7682	6999	-	-	5998	-	-
230 7ss TL	128.8	10002	-	8090	9400	-	8090	8309	-	8090	7526	-	-	6456	-	-
240 7ss TL	134.4	10341	-	8336	9726	-	8336	8606	-	8336	7802	-	-	6699	-	-
250 7ss TL	140	10641	-	8564	10015	-	8564	8872	-	8564	8049	-	-	6917	-	-
260 7ss TL	145.6	10955	-	8798	10318	-	8798	9151	-	8798	8307	-	-	7145	-	-
280 7ss TL	156.8	11528	-	9239	10871	-	9239	9662	-	9239	8784	-	-	7568	-	-
300 8ss TL	168	12169	-	9709	11490	-	9709	10234	-	9709	9316	-	-	8041	-	-
320 8ss TL	179.2	12657	-	10107	11964	-	10107	10678	-	10107	9734	-	-	8414	-	-

1 The following modification factors were used for calculations: $K_{D,std\ term} = K_H = K_S = K_T = 1.0$; $K_{D,longterm} = 0.65$
2 Span table includes panel self-weight plus 1.0kPa for miscellaneous dead load allowance.
3 CLT is NOT an isotropic material. Presented values to be used for bending of panels in the major strength axis.
4 Span tables are intended for preliminary design only – responsible engineer shall ensure that the panel meets all the requirements set forth in local Building Code for the project.
5 Tabulated deflection spans are the governing case of L/240, L/480, L360 which corresponds to total, live and long term serviceability limits, respectively. Engineer to ensure limits are appropriate.
6 Instantaneous elastic deflection due to long-term loads has been adjusted by a creep factor of 2.0 for dry service condition.
7 Spans are assumed to be equal for double span panels.
8 Panels assumed to be simply supported with pin support conditions spanning from center lines of support.
9 Non-structural flooring topping is assumed to provide an enhanced vibration effect on double spans. Values include a 20% increase. Single spans not enhanced by non-structural floor topping.
10 Pattern live loads not considered for deflection.
11 Spans based on one-way, strong axis bending only
12 Fire ratings not considered
13 Nominal density of spruce = 5.5 kN/m³ per ONORM B 1991-1-1:2011
14 Indicates governing span case
15 - Indicates panel is strength (ULS) governed, therefore deflection and/or vibration is not a governing factor.

5.2 FLOORS WITH 38 MM GYPSUM TOPPING

according to CSA O86-14

		LIVE LOAD (DOUBLE SPAN)														
		1.9 kPa RESIDENTIAL			2.4 kPa OFFICE / CLASSROOM			3.6 kPa MECHANICAL ROOM			4.8 kPa ASSEMBLY			7.2 kPa LIBRARY		
Layup	Mass	Strength	Deflec-tion	Vibra-tion	Strength	Deflec-tion	Vibra-tion	Strength	Deflec-tion	Vibra-tion	Strength	Deflec-tion	Vibra-tion	Strength	Deflec-tion	Vibra-tion
	kg/m²	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
60 3s TL	33.6	2673	-	-	2504	-	-	2200	-	-	1985	-	-	1696	-	-
70 3s TL	39.2	3034	-	-	2843	-	-	2502	-	-	2259	-	-	1931	-	-
80 3s TL	44.8	3557	-	-	3336	-	-	2939	-	-	2657	-	-	2273	-	-
80 3s TL V2	44.8	3361	-	-	3152	-	-	2777	-	-	2510	-	-	2148	-	-
90 3s TL	50.4	3935	-	-	3693	-	-	3258	-	-	2947	-	-	2524	-	-
100 3s TL	56	4408	-	4354	4141	-	-	3657	-	-	3310	-	-	2838	-	-
100 3s TL V2	56	4286	-	4283	4026	-	-	3555	-	-	3219	-	-	2759	-	-
105 3s TL	58.8	4549	-	4479	4274	-	-	3777	-	-	3420	-	-	2933	-	-
110 3s TL	61.6	4791	-	4660	4503	-	-	3981	-	-	3607	-	-	3095	-	-
120 3s TL	67.2	5152	-	4950	4846	-	-	4289	-	-	3889	-	-	3340	-	-
100 5s TL	56	3955	-	-	3715	-	-	3281	-	-	2970	-	-	2546	-	-
110 5s TL	61.6	4247	-	-	3992	-	-	3530	-	-	3198	-	-	2744	-	-
120 5s TL	67.2	4932	-	4827	4639	-	-	4106	-	-	3723	-	-	3197	-	-
120 5s TL V2	67.2	4446	-	-	4182	-	-	3702	-	-	3356	-	-	2882	-	-
130 5s TL	72.8	5243	-	5087	4935	-	-	4373	-	-	3968	-	-	3410	-	-
130 5s TL V2	72.8	4697	-	-	4422	-	-	3918	-	-	3555	-	-	3056	-	-
140 5s TL	78.4	5824	-	5493	5485	-	-	4866	-	-	4418	-	-	3801	-	-
140 5s TL V2	78.4	4879	-	-	4596	-	-	4077	-	-	3702	-	-	3185	-	-
150 5s TL	84	6146	-	5754	5792	-	5754	5144	-	-	4674	-	-	4024	-	-
150 5s TL V2	84	5760	-	5542	5429	-	-	4821	-	-	4381	-	-	3772	-	-
150 5s TL V3	84	5101	-	-	4808	-	-	4270	-	-	3879	-	-	3340	-	-
160 5s TL	89.6	6463	-	6010	6096	-	6010	5419	-	-	4927	-	-	4246	-	-
160 5s TL V2	89.6	5326	-	-	5023	-	-	4466	-	-	4060	-	-	3499	-	-
170 5s TL	95.2	6703	-	6222	6326	-	6222	5630	-	-	5123	-	-	4418	-	-
170 5s TL V2	95.2	6226	-	5961	5875	-	-	5229	-	-	4758	-	-	4103	-	-
175 5s TL	98	6625	-	6221	6254	-	6221	5569	-	-	5069	-	-	4374	-	-
180 5s TL	100.8	6988	-	6457	6599	-	6457	5879	-	-	5353	-	-	4620	-	-
180 5s TL V2	100.8	6470	-	6175	6110	-	-	5443	-	-	4956	-	-	4278	-	-
190 5s TL	106.4	7210	-	6658	6813	-	6658	6076	-	-	5535	-	-	4782	-	-
200 5s TL	112	7468	-	6876	7060	-	6876	6303	-	-	5746	-	-	4968	-	-

* See notes on pg. 21

5.2 FLOORS WITH 38 MM GYPSUM TOPPING (continued)

		LIVE LOAD (DOUBLE SPAN)														
		1.9 kPa RESIDENTIAL			2.4 kPa OFFICE / CLASSROOM			3.6 kPa MECHANICAL ROOM			4.8 kPa ASSEMBLY			7.2 kPa LIBRARY		
Layup	Mass	Strength	Deflec-tion	Vibra-tion	Strength	Deflec-tion	Vibra-tion	Strength	Deflec-tion	Vibra-tion	Strength	Deflec-tion	Vibra-tion	Strength	Deflec-tion	Vibra-tion
	kg/m²	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
140 7s TL	78,4	5137	-	5108	4838	-	-	4292	-	-	3897	-	-	3353	-	-
160 7s TL	89,6	5473	-	5457	5162	-	-	4589	-	-	4173	-	-	3596	-	-
180 7s TL	100,8	5788	-	-	5466	-	-	4870	-	-	4434	-	-	3827	-	-
180 7s TL V2	100,8	6788	-	6349	6410	-	6349	5710	-	-	5199	-	-	4488	-	-
200 7s TL	112	6248	-	6200	5907	-	-	5273	-	-	4807	-	-	4157	-	-
210 7s TL	117,6	7409	-	6923	7009	-	6923	6263	-	-	5713	-	-	4944	-	-
220 7s TL	123,2	7464	-	7030	7065	-	7030	6319	-	-	5768	-	-	4995	-	-
220 7s TL V2	123,2	8338	-	7496	7892	-	7496	7058	-	-	6443	-	-	5580	-	-
230 7s TL	128,8	7713	-	7242	7304	-	7242	6539	-	-	5973	-	-	5177	-	-
240 7s TL	134,4	7959	-	7451	7542	-	7451	6758	-	-	6177	-	-	5358	-	-
245 7s TL	137,2	8485	-	7772	8042	-	7772	7210	-	-	6592	-	-	5720	-	-
260 7s TL	145,6	8996	-	8157	8533	-	8157	7660	-	-	7010	-	-	6090	-	-
160 5ss TL	89,6	6783	-	6180	6397	-	6180	5687	-	-	5171	-	-	4456	-	-
180 7ss TL	100,8	7471	-	6712	7054	-	6712	6285	-	-	5722	-	-	4939	-	-
200 7ss TL	112	8126	-	7221	7682	-	7221	6858	-	-	6252	-	-	5406	-	-
210 7ss TL	117,6	8400	-	7446	7946	-	7446	7100	-	-	6477	-	-	5605	-	-
220 7ss TL	123,2	9006	-	7839	8524	-	7839	7624	-	-	6960	-	-	6027	-	-
220 7ss TL V2	123,2	8697	-	7682	8232	-	7682	7363	-	-	6721	-	-	5821	-	-
230 7ss TL	128,8	9336	-	8090	8841	-	8090	7915	-	-	7230	-	-	6266	-	-
240 7ss TL	134,4	9660	-	8336	9153	-	8336	8202	-	-	7497	-	-	6502	-	-
250 7ss TL	140	9948	-	8564	9430	-	8564	8458	-	-	7736	-	-	6715	-	-
260 7ss TL	145,6	10249	-	8798	9721	-	8798	8727	-	-	7986	-	-	6938	-	-
280 7ss TL	156,8	10761	-	9239	10254	-	9239	9222	-	-	8449	-	-	7351	-	-
300 8ss TL	168	11296	-	9709	10850	-	9709	9774	-	9709	8965	-	-	7812	-	-
320 8ss TL	179,2	11687	-	10107	11310	-	10107	10205	-	10107	9371	-	-	8177	-	-

1 The following modification factors were used for calculations: $K_{D,std\ term} = K_H = K_S = K_T = 1.0$; $K_{D,longterm} = 0.65$
2 Span table includes panel self-weight, 0.70 kPa for 38mm gypcrete topping, plus 1.0kPa for miscellaneous dead load allowance.
3 CLT is NOT an isotropic material. Presented values to be used for bending of panels in the major strength axis.
4 Span tables are intended for preliminary design only – responsible engineer shall ensure that the panel meets all the requirements set forth in local Building Code for the project.
5 Tabulated deflection spans is the governing case of L/240, L/480, L360 which corresponds to total, live and long term serviceability limits, respectively. Engineer to ensure limits are appropriate.
6 Instantaneous elastic deflection due to long-term loads has been adjusted by a creep factor of 2.0 for dry service condition.
7 Panels assumed to be simply supported with pin support conditions spanning from center lines of support.
8 Non-structural flooring topping is assumed to provide an enhanced vibration effect on double spans. Values include a 20% increase. Single spans not enhanced by non-structural floor topping.
8 Pattern live loads not considered for deflection.
10 Nominal density of spruce = 5.5 kN/m³ per ONORM B 1991-1-1:2011
11 Spans based on one-way, strong axis bending only
12 Fire ratings not considered
13 Indicates governing span case
14 - Indicates panel is strength (ULS) governed, therefore deflection and/or vibration is not a governing factor.

5.3 FLOORS WITH 50 MM CONCRETE TOPPING

according to CSA O86-14

		LIVE LOAD (DOUBLE SPAN)														
		1.9 kPa RESIDENTIAL			2.4 kPa OFFICE / CLASSROOM			3.6 kPa MECHANICAL ROOM			4.8 kPa ASSEMBLY			7.2 kPa LIBRARY		
Layup	Mass	Strength	Deflec-tion	Vibra-tion	Strength	Deflec-tion	Vibra-tion	Strength	Deflec-tion	Vibra-tion	Strength	Deflec-tion	Vibra-tion	Strength	Deflec-tion	Vibra-tion
	kg/m²	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
60 3s TL	33.6	2490	-	-	2383	-	-	2117	-	-	1924	-	-	1657	-	-
70 3s TL	39.2	2828	-	-	2708	-	-	2408	-	-	2190	-	-	1887	-	-
80 3s TL	44.8	3318	-	-	3179	-	-	2830	-	-	2575	-	-	2221	-	-
80 3s TL V2	44.8	3135	-	-	3004	-	-	2674	-	-	2433	-	-	2099	-	-
90 3s TL	50.4	3673	-	-	3521	-	-	3138	-	-	2857	-	-	2467	-	-
100 3s TL	56	4117	-	-	3949	-	-	3523	-	-	3210	-	-	2774	-	-
100 3s TL V2	56	4003	-	-	3840	-	-	3425	-	-	3121	-	-	2697	-	-
105 3s TL	58.8	4250	-	-	4078	-	-	3639	-	-	3317	-	-	2867	-	-
110 3s TL	61.6	4477	-	-	4297	-	-	3837	-	-	3499	-	-	3025	-	-
120 3s TL	67.2	4817	-	-	4627	-	-	4135	-	-	3773	-	-	3265	-	-
100 5s TL	56	3694	-	-	3544	-	-	3161	-	-	2880	-	-	2489	-	-
110 5s TL	61.6	3969	-	-	3810	-	-	3401	-	-	3101	-	-	2682	-	-
120 5s TL	67.2	4612	-	-	4429	-	-	3958	-	-	3612	-	-	3126	-	-
120 5s TL V2	67.2	4157	-	-	3993	-	-	3568	-	-	3256	-	-	2818	-	-
130 5s TL	72.8	4905	-	-	4714	-	-	4217	-	-	3850	-	-	3335	-	-
130 5s TL V2	72.8	4395	-	-	4223	-	-	3778	-	-	3449	-	-	2988	-	-
140 5s TL	78.4	5452	-	-	5242	-	-	4694	-	-	4288	-	-	3717	-	-
140 5s TL V2	78.4	4568	-	-	4392	-	-	3932	-	-	3593	-	-	3114	-	-
150 5s TL	84	5757	-	5754	5537	-	-	4963	-	-	4537	-	-	3936	-	-
150 5s TL V2	84	5395	-	-	5190	-	-	4652	-	-	4252	-	-	3689	-	-
150 5s TL V3	84	4778	-	-	4596	-	-	4119	-	-	3766	-	-	3267	-	-
160 5s TL	89.6	6057	-	6010	5830	-	-	5230	-	-	4784	-	-	4153	-	-
160 5s TL V2	89.6	4992	-	-	4804	-	-	4310	-	-	3942	-	-	3423	-	-
170 5s TL	95.2	6286	-	6222	6053	-	-	5435	-	-	4974	-	-	4322	-	-
170 5s TL V2	95.2	5838	-	-	5622	-	-	5048	-	-	4620	-	-	4014	-	-
175 5s TL	98	6214	-	-	5986	-	-	5377	-	-	4923	-	-	4279	-	-
180 5s TL	100.8	6556	-	6457	6317	-	-	5677	-	-	5199	-	-	4520	-	-
180 5s TL V2	100.8	6070	-	-	5848	-	-	5256	-	-	4813	-	-	4185	-	-
190 5s TL	106.4	6768	-	6658	6524	-	-	5868	-	-	5377	-	-	4679	-	-
200 5s TL	112	7014	-	6876	6764	-	-	6089	-	-	5583	-	-	4862	-	-

* See notes on pg. 23

5.3 FLOORS WITH 50 MM CONCRETE TOPPING (continued)

		LIVE LOAD (DOUBLE SPAN)														
		1.9 kPa RESIDENTIAL			2.4 kPa OFFICE / CLASSROOM			3.6 kPa MECHANICAL ROOM			4.8 kPa ASSEMBLY			7.2 kPa LIBRARY		
Layup	Mass	Strength	Deflec-tion	Vibra-tion	Strength	Deflec-tion	Vibra-tion	Strength	Deflec-tion	Vibra-tion	Strength	Deflec-tion	Vibra-tion	Strength	Deflec-tion	Vibra-tion
	kg/m²	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
140 7s TL	78.4	4809	-	-	4623	-	-	4140	-	-	3782	-	-	3279	-	-
160 7s TL	89.6	5129	-	-	4937	-	-	4429	-	-	4051	-	-	3517	-	-
180 7s TL	100.8	5431	-	-	5232	-	-	4702	-	-	4306	-	-	3744	-	-
180 7s TL V2	100.8	6368	-	6349	6136	-	-	5514	-	-	5050	-	-	4391	-	-
200 7s TL	112	5868	-	-	5659	-	-	5094	-	-	4671	-	-	4067	-	-
210 7s TL	117.6	6962	-	6923	6717	-	-	6052	-	-	5552	-	-	4838	-	-
220 7s TL	123.2	7017	-	-	6773	-	-	6108	-	-	5606	-	-	4889	-	-
220 7s TL V2	123.2	7838	-	7496	7566	-	7496	6823	-	-	6263	-	-	5461	-	-
230 7s TL	128.8	7234	-	-	7006	-	-	6322	-	-	5807	-	-	5067	-	-
240 7s TL	134.4	7445	-	-	7236	-	-	6536	-	-	6006	-	-	5245	-	-
245 7s TL	137.2	7926	-	7772	7718	-	-	6973	-	-	6410	-	-	5600	-	-
260 7s TL	145.6	8371	-	8157	8193	-	8157	7411	-	-	6818	-	-	5962	-	-
160 5ss TL	89.6	6357	-	6180	6118	-	-	5489	-	-	5020	-	-	4359	-	-
180 7ss TL	100.8	7009	-	6712	6753	-	6712	6069	-	-	5558	-	-	4832	-	-
200 7ss TL	112	7631	-	7221	7360	-	7221	6625	-	-	6075	-	-	5290	-	-
210 7ss TL	117.6	7893	-	7446	7615	-	7446	6861	-	-	6294	-	-	5485	-	-
220 7ss TL	123.2	8466	-	7839	8172	-	7839	7369	-	-	6764	-	-	5899	-	-
220 7ss TL V2	123.2	8176	-	7682	7892	-	7682	7117	-	-	6533	-	-	5697	-	-
230 7ss TL	128.8	8756	-	8090	8480	-	8090	7653	-	-	7028	-	-	6134	-	-
240 7ss TL	134.4	9035	-	8336	8782	-	8336	7932	-	-	7289	-	-	6365	-	-
250 7ss TL	140	9280	-	8564	9052	-	8564	8182	-	-	7523	-	-	6574	-	-
260 7ss TL	145.6	9537	-	8798	9334	-	8798	8444	-	-	7768	-	-	6793	-	-
280 7ss TL	156.8	10001	-	9239	9853	-	9239	8927	-	-	8220	-	-	7199	-	-
300 8ss TL	168	10522	-	9709	10432	-	9709	9465	-	-	8726	-	-	7651	-	-
320 8ss TL	179.2	10910	-	10107	10882	-	10107	9887	-	-	9124	-	-	8011	-	-

1 The following modification factors were used for calculations: $K_{D,std\ term} = K_H = K_S = K_T = 1.0$; $K_{D,longterm} = 0.65$
2 Span table includes panel self-weight, 1.20 kPa for 50mm concrete topping, plus 1.0kPa for miscellaneous dead load allowance.
3 CLT is NOT an isotropic material. Presented values to be used for bending of panels in the major strength axis.
4 Span tables are intended for preliminary design only – responsible engineer shall ensure that the panel meets all the requirements set forth in local Building Code for the project.
5 Tabulated deflection spans is the governing case of L/240, L/480, L360 which corresponds to total, live and long term serviceability limits, respectively. Engineer to ensure limits are appropriate.
6 Instantaneous elastic deflection due to long-term loads has been adjusted by a creep factor of 2.0 for dry service condition.
7 Panels assumed to be simply supported with pin support conditions spanning from center lines of support.
8 Non-structural flooring topping is assumed to provide an enhanced vibration effect on double spans. Values include a 20% increase. Single spans not enhanced by non-structural floor topping.
9 Pattern live loads not considered for deflection.
10 Nominal density of spruce = 5.5 kN/m³ per ONORM B 1991-1-1:2011
11 Spans based on one-way, strong axis bending only
12 Fire ratings not considered
13 Indicates governing span case
14 - Indicates panel is strength (ULS) governed, therefore deflection and/or vibration is not a governing factor.

06 KLH® ROOF PANELS - SINGLE SPAN

6.1 ROOFS WITHOUT CONCRETE TOPPING

according to CSA O86-14

		BASE SNOW LOAD (SINGLE SPAN)											
		1.0 kPa ROOF SNOW LOAD		1.5 kPa ROOF SNOW LOAD		2.0 kPa ROOF SNOW LOAD		3.0 kPa ROOF SNOW LOAD		4.0 kPa ROOF SNOW LOAD		8.5 kPa ROOF SNOW LOAD	
Layup	Mass	Strength	Deflection	Strength	Deflection	Strength	Deflection	Strength	Deflection	Strength	Deflection	Strength	Deflection
	kg/m²	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
60 3s TL	33.6	3882	2856	3411	2856	3078	2815	2628	2598	2331	-	1665	-
70 3s TL	39.2	4375	3209	3855	3209	3485	3199	2983	2958	2649	-	1897	-
80 3s TL	44.8	5096	3681	4503	3681	4079	3681	3498	3438	3111	-	2233	-
80 3s TL V2	44.8	4814	3530	4254	3530	3853	3530	3305	3295	2939	-	2110	-
90 3s TL	50.4	5600	4023	4963	4023	4503	4023	3870	3800	3446	-	2480	-
100 3s TL	56	6235	4447	5540	4447	5035	4447	4337	4246	3866	-	2788	-
100 3s TL V2	56	6063	4343	5387	4343	4896	4343	4217	4145	3760	-	2711	-
105 3s TL	58.8	6415	4566	5707	4566	5191	4566	4476	4380	3993	-	2882	-
110 3s TL	61.6	6736	4775	6000	4775	5462	4775	4714	4604	4208	-	3041	-
120 3s TL	67.2	7202	5086	6430	5086	5863	5086	5071	4948	4531	-	3282	-
100 5s TL	56	5595	4140	4971	4140	4518	4140	3891	-	3469	-	2502	-
110 5s TL	61.6	5971	4430	5319	4430	4842	4430	4179	-	3730	-	2696	-
120 5s TL	67.2	6894	4964	6156	4964	5613	4964	4854	4830	4338	-	3142	-
120 5s TL V2	67.2	6215	4626	5549	4626	5060	4626	4376	-	3910	-	2832	-
130 5s TL	72.8	7288	5257	6522	5257	5956	5257	5161	5160	4617	-	3352	-
130 5s TL V2	72.8	6530	4879	5844	4879	5337	4879	4624	-	4137	-	3003	-
140 5s TL	78.4	8052	5705	7222	5705	6605	5705	5734	5643	5136	-	3736	-
140 5s TL V2	78.4	6746	5059	6051	5059	5534	5059	4804	-	4303	-	3130	-
150 5s TL	84	8453	5997	7598	5997	6959	5997	6052	5977	5427	-	3956	-
150 5s TL V2	84	7922	5731	7121	5731	6522	5731	5672	-	5086	-	3708	-
150 5s TL V3	84	7016	5284	6306	5284	5776	5284	5023	-	4504	-	3283	-
160 5s TL	89.6	8845	6282	7967	6282	7307	6282	6366	6282	5714	-	4174	-
160 5s TL V2	89.6	7289	5508	6565	5508	6021	5508	5246	-	4709	-	3440	-
170 5s TL	89.6	9226	6568	8310	6568	7622	6568	6640	6568	5960	-	4354	-
170 5s TL V2	95.2	8479	6161	7652	6161	7028	6161	6133	-	5511	-	4034	-
175 5s TL	95.2	9048	6504	8166	6504	7499	6504	6545	6504	5881	-	4305	-
180 5s TL	98	9521	6781	8600	6781	7904	6781	6904	6781	6207	-	4548	-
180 5s TL V2	100.8	8769	6393	7929	6393	7292	6393	6374	-	5734	-	4206	-
190 5s TL	100.8	9827	7009	8886	7009	8172	7009	7143	7009	6426	-	4713	-
200 5s TL	106.4	10131	7245	9177	7245	8451	7245	7399	7245	6663	-	4897	-

* See notes on pg. 25

6.1 ROOFS WITHOUT CONCRETE TOPPING (continued)

		BASE SNOW LOAD (SINGLE SPAN)											
		1.0 kPa ROOF SNOW LOAD		1.5 kPa ROOF SNOW LOAD		2.0 kPa ROOF SNOW LOAD		3.0 kPa ROOF SNOW LOAD		4.0 kPa ROOF SNOW LOAD		8.5 kPa ROOF SNOW LOAD	
Layup	Mass	Strength	Deflection	Strength	Deflection	Strength	Deflection	Strength	Deflection	Strength	Deflection	Strength	Deflection
	kg/m²	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
140 7s TL	112	6671	4852	6053	4852	5581	4852	4894	4852	4412	-	3249	-
160 7s TL	78.4	7655	5771	6866	5771	6279	5771	5451	-	4882	-	3552	-
180 7s TL	89.6	8011	6097	7216	6097	6618	6097	5766	-	5176	-	3781	-
180 7s TL V2	100.8	9200	6625	8319	6625	7650	6625	6688	6625	6016	-	4413	-
200 7s TL	100.8	8562	6514	7742	6514	7120	6514	6224	-	5599	-	4107	-
210 7s TL	112	10006	7278	9080	7278	8371	7278	7342	7278	6618	-	4873	-
220 7s TL	117.6	10036	7367	9123	7367	8421	7367	7397	7367	6674	-	4924	-
220 7s TL V2	123.2	11038	7875	10111	7875	9344	7875	8220	7875	7424	-	5488	-
230 7s TL	123.2	10265	7579	9403	7579	8689	7579	7644	7579	6904	-	5104	-
240 7s TL	128.8	10481	7787	9679	7787	8954	7787	7889	7787	7132	-	5282	-
245 7s TL	134.4	11033	8120	10267	8120	9508	8120	8390	8120	7591	-	5633	-
260 7s TL	137.2	11699	8594	10927	8594	10126	8594	8941	8594	8093	-	6012	-
160 5ss TL	145.6	8178	5731	7720	5731	7165	5731	6340	5731	5747	5694	4280	-
180 7ss TL	100.8	10126	7044	9156	7044	8420	7044	7360	7044	6621	-	4857	-
200 7ss TL	112	10915	7607	9905	7607	9131	7607	8009	7607	7219	-	5316	-
210 7ss TL	117.6	11234	7807	10212	7807	9426	7807	8280	7807	7470	-	5512	-
220 7ss TL	123.2	11923	8262	10921	8262	10092	8262	8879	8262	8019	-	5928	-
220 7ss TL V2	123.2	11514	8065	10547	8065	9747	8065	8574	8065	7744	-	5725	-
230 7ss TL	128.8	12230	8538	11293	8538	10448	8538	9205	8538	8321	-	6164	-
240 7ss TL	134.4	12527	8808	11657	8808	10796	8808	9526	8808	8619	-	6396	-
250 7ss TL	140	12776	9001	11976	9001	11104	9001	9811	9001	8885	-	6606	-
260 7ss TL	145.6	13041	9255	12311	9255	11426	9255	10110	9255	9164	-	6826	-
280 7ss TL	156.8	13502	9678	12916	9678	12011	9678	10657	9678	9677	-	7233	-
300 8ss TL	168	14042	10227	13596	10227	12667	10227	11268	10227	10249	10227	7688	-
320 8ss TL	179.2	14402	10595	14102	10595	13163	10595	11737	10595	10693	10595	8049	-

1 Span table assumes dry service conditions.
2 The following modification factors were used for calculations: $K_{D,std\ term} = K_H = K_S = K_T = 1.0$; $K_{D,longterm} = 0.65$
3 Snow load is based on NBCC 2015 with following factors: $I_S = 1.0$ for ULS; $I_S = 0.9$ for SLS; $C_W = C_s = C_a = 1.0$.
4 Panels assumed to be simply supported with pin support conditions spanning from center lines of support and are to be used for preliminary design only.
5 Span table above includes panel self-weight plus 0.5 kPa miscellaneous dead load.
6 Tabulated deflection spans is the governing case of L/180, L/240, L360 which corresponds to total, snow and long term serviceability limits, respectively. Engineer to ensure limits are appropriate.
7 Ponding or ceiling finishes may require higher deflection limits.
8 Pattern snow loads not considered for deflection.
9 CLT is NOT an isotropic material. Presented values to be used for bending of panels in the major strength axis.
10 Spans based on one-way, strong axis bending only
11 Fire ratings not considered
12 Indicates governing span case
13 - Indicates panel is strength (ULS) governed, therefore deflection and/or vibration is not a governing factor.

07 KLH® ROOF PANELS - DOUBLE SPAN

7.1 ROOFS WITHOUT CONCRETE TOPPING

according to CSA O86-14.

		BASE SNOW LOAD (DOUBLE SPAN)											
		1.0 kPa ROOF SNOW LOAD		1.5 kPa ROOF SNOW LOAD		2.0 kPa ROOF SNOW LOAD		3.0 kPa ROOF SNOW LOAD		4.0 kPa ROOF SNOW LOAD		8.5 kPa ROOF SNOW LOAD	
Layup	Mass	Strength	Deflection	Strength	Deflection	Strength	Deflection	Strength	Deflection	Strength	Deflection	Strength	Deflection
	kg/m²	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
60 3s TL	33.6	3882	3791	3411	-	3078	-	2628	-	2331	-	1665	-
70 3s TL	39.2	4375	4256	3855	-	3485	-	2983	-	2649	-	1897	-
80 3s TL	44.8	5096	4886	4503	-	4079	-	3498	-	3111	-	2233	-
80 3s TL V2	44.8	4814	4681	4254	-	3853	-	3305	-	2939	-	2110	-
90 3s TL	50.4	5600	5337	4963	-	4503	-	3870	-	3446	-	2480	-
100 3s TL	56	6235	5905	5540	-	5035	-	4337	-	3866	-	2788	-
100 3s TL V2	56	6063	5757	5387	-	4896	-	4217	-	3760	-	2711	-
105 3s TL	58.8	6415	6054	5707	-	5191	-	4476	-	3993	-	2882	-
110 3s TL	61.6	6736	6334	6000	-	5462	-	4714	-	4208	-	3041	-
120 3s TL	67.2	7202	6741	6430	-	5863	-	5071	-	4531	-	3282	-
100 5s TL	56	5595	5498	4971	-	4518	-	3891	-	3469	-	2502	-
110 5s TL	61.6	5971	5886	5319	-	4842	-	4179	-	3730	-	2696	-
120 5s TL	67.2	6894	6590	6156	-	5613	-	4854	-	4338	-	3142	-
120 5s TL V2	67.2	6215	6139	5549	-	5060	-	4376	-	3910	-	2832	-
130 5s TL	72.8	7288	6983	6522	-	5956	-	5161	-	4617	-	3352	-
130 5s TL V2	72.8	6530	6478	5844	-	5337	-	4624	-	4137	-	3003	-
140 5s TL	78.4	8052	7572	7222	-	6605	-	5734	-	5136	-	3736	-
140 5s TL V2	78.4	6746	6708	6051	-	5534	-	4804	-	4303	-	3130	-
150 5s TL	84	8453	7963	7598	-	6959	-	6052	-	5427	-	3956	-
150 5s TL V2	84	7922	7604	7121	-	6522	-	5672	-	5086	-	3708	-
150 5s TL V3	84	7016	7010	6306	-	5776	-	5023	-	4504	-	3283	-
160 5s TL	89.6	8845	8345	7967	-	7307	-	6366	-	5714	-	4174	-
160 5s TL V2	89.6	7289	-	6565	-	6021	-	5246	-	4709	-	3440	-
170 5s TL	95.2	9129	8594	8239	-	7567	-	6604	-	5934	-	4344	-
170 5s TL V2	95.2	8479	8169	7652	-	7028	-	6133	-	5511	-	4034	-
175 5s TL	98	9001	8570	8131	-	7473	-	6527	-	5868	-	4300	-
180 5s TL	100.8	9472	8940	8564	-	7876	-	6885	-	6193	-	4543	-
180 5s TL V2	100.8	8769	8480	7929	-	7292	-	6374	-	5734	-	4206	-
190 5s TL	106.4	9728	9172	8812	-	8114	-	7105	-	6398	-	4702	-
200 5s TL	112	10031	9489	9103	-	8392	-	7360	-	6634	-	4886	-

* See notes on pg. 27

7.1 ROOFS WITHOUT CONCRETE TOPPING (continued)

		BASE SNOW LOAD (DOUBLE SPAN)											
		1.0 kPa ROOF SNOW LOAD		1.5 kPa ROOF SNOW LOAD		2.0 kPa ROOF SNOW LOAD		3.0 kPa ROOF SNOW LOAD		4.0 kPa ROOF SNOW LOAD		8.5 kPa ROOF SNOW LOAD	
Layup	Mass	Strength	Deflection	Strength	Deflection	Strength	Deflection	Strength	Deflection	Strength	Deflection	Strength	Deflection
	kg/m²	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
140 7s TL	78.4	7102	6978	6370	-	5826	-	5057	-	4530	-	3295	-
160 7s TL	89.6	7490	7441	6746	-	6187	-	5391	-	4839	-	3535	-
180 7s TL	100.8	7846	-	7094	-	6524	-	5703	-	5130	-	3763	-
180 7s TL V2	100.8	9200	8798	8319	-	7650	-	6688	-	6016	-	4413	-
200 7s TL	112	8392	-	7616	-	7021	-	6158	-	5550	-	4087	-
210 7s TL	117.6	9909	9542	9007	-	8314	-	7303	-	6589	-	4862	-
220 7s TL	123.2	9881	9659	9051	-	8364	-	7358	-	6646	-	4913	-
220 7s TL V2	123.2	11038	10459	10111	-	9344	-	8220	-	7424	-	5488	-
230 7s TL	128.8	10104	9937	9330	-	8632	-	7605	-	6875	-	5092	-
240 7s TL	134.4	10322	10211	9605	-	8896	-	7849	-	7102	-	5270	-
245 7s TL	137.2	10950	10710	10228	-	9478	-	8369	-	7575	-	5627	-
260 7s TL	145.6	11446	11211	10806	-	10029	-	8874	-	8044	-	5991	-
160 5ss TL	89.6	9282	8541	8360	-	7668	-	6680	-	5997	-	4381	-
180 7ss TL	100.8	10126	9346	9156	-	8420	-	7360	-	6621	-	4857	-
200 7ss TL	112	10915	10101	9905	-	9131	-	8009	-	7219	-	5316	-
210 7ss TL	117.6	11234	10350	10212	-	9426	-	8280	-	7470	-	5512	-
220 7ss TL	123.2	11923	10960	10921	-	10092	-	8879	-	8019	-	5928	-
220 7ss TL V2	123.2	11514	10695	10547	-	9747	-	8574	-	7744	-	5725	-
230 7ss TL	128.8	12230	11330	11293	-	10448	-	9205	-	8321	-	6164	-
240 7ss TL	134.4	12527	11691	11657	-	10796	-	9526	-	8619	-	6396	-
250 7ss TL	140	12776	11928	11976	11928	11104	-	9811	-	8885	-	6606	-
260 7ss TL	145.6	13041	12268	12311	12268	11426	-	10110	-	9164	-	6826	-
280 7ss TL	156.8	13502	12815	12916	12815	12011	-	10657	-	9677	-	7233	-
300 8ss TL	168	14042	13570	13596	13570	12667	-	11268	-	10249	-	7688	-
320 8ss TL	179.2	14402	14045	14102	14045	13163	-	11737	-	10693	-	8049	-

1 Span table assumes dry service conditions.
2 The following modification factors were used for calculations: $K_{D,std\ term} = K_H = K_S = K_T = 1.0$; $K_{D,longterm} = 0.65$
3 Snow load is based on NBCC 2015 with following factors: $I_S = 1.0$ for ULS; $I_S = 0.9$ for SLS; $C_W = C_s = C_a = 1.0$.
4 Panels assumed to be simply supported with pin support conditions spanning from center lines of support and are to be used for preliminary design only.
5 Span table above includes panel self-weight plus 0.5 kPa miscellaneous dead load.
6 Tabulated deflection spans is the governing case of L/180, L/240, L360 which corresponds to total, snow and long term serviceability limits, respectively. Engineer to ensure limits are appropriate.
7 Ponding or ceiling finishes may require higher deflection limits.
8 Pattern snow loads not considered for deflection.
9 Spans are assumed to be equal for double span panels.
10 CLT is NOT an isotropic material. Presented values to be used for bending of panels in the major strength axis.
11 Spans based on one-way, strong axis bending only
12 Fire ratings not considered
13 Indicates governing span case
14 - Indicates panel is strength (ULS) governed, therefore deflection and/or vibration is not a governing factor.

08 ADDITIONAL DESIGN PROCEDURES

8.1 FIRE DESIGN PROCEDURE FOR CLT PANELS

See CSA O86, Annex B, for procedures to determine the structural resistance of the effective cross section of a CLT panel, defined as the initial cross section reduced by the char layer depth and the zero-strength layer depth on each exposed surface for a given fire duration.

8.2 DEFLECTION OF HORIZONTAL CLT PANELS DUE TO OUT-OF-PLANE LOADS

See CSA O86, Annex A, Section A.8.5.2 for procedures for calculating the maximum deflection of a CLT panel due to out-of-plane loading, including the effects of wood creep.

8.3 VIBRATION ANALYSIS OF CLT PANELS DUE TO OUT-OF-PLANE LOADS

See CSA O86, Annex A, Section A.8.5.3 for procedures to calculate the vibration-controlled span limit for CLT floors, including multiple-span floors with a non-structural element, such as a concrete topping, that is considered to enhance vibration performance.

8.4 CLT AS COMPRESSION MEMBERS WITH OR WITHOUT SIMULTANEOUS OUT-OF-PLANE LOADING

CSA O86, Sections 8.4.5 and 8.4.6, illustrate procedures for calculating the resistance of CLT panels subjected to compressive axial loads and combined out-of-plane (flatwise) bending and compressive axial load effects

8.5 CLT IN-PLANE BENDING

The engineer should use a rational method to calculate the bending capacity of CLT members used for in-plane loading situations (edgewise bending), such as lintels or cantilevered walls.

8.6 FASTENERS

The engineer should review literature provided by the fastener manufacturer for fastener shear and/or withdrawal capacities, giving consideration, if necessary, to how the fasteners are oriented relative to the direction of grain of the laminations involved in the connection.

8.7 FIRE PERFORMANCE TESTING AT SOUTHWEST RESEARCH INSTITUTE (SWRI ®)

ASTM E119-16 STANDARD TEST METHODS FOR FIRE TESTS OF BUILDING CONSTRUCTION AND MATERIALS

60-minute Fire Resistance Rating

5-ply 130 mm thick CLT, load bearing roof assembly, SwRI Project No. 01.23472.01.001, June 6, 2018

5-ply 160 mm thick CLT, load bearing floor assembly, SwRI Project No. 01.23472.01.004, June 29, 2018

ASTM E119-19 STANDARD TEST METHODS FOR FIRE TESTS OF BUILDING CONSTRUCTION AND MATERIALS

120-minute Fire Resistance Rating

5-ply 175 mm thick CLT, load bearing wall assembly, SwRI Project No. 01.25700.01.001, April 24, 2020

5-ply 175 mm thick CLT, load bearing floor assembly, SwRI Project No. 01.25700.01.002, April 24, 2020

5-ply 180 mm thick CLT, load bearing floor assembly, SwRI Project No. 01.25700.01.003, October 2, 2020

ASTM E84-16 STANDARD TEST METHOD FOR SURFACE BURNING CHARACTERISTICS OF BUILDING MATERIALS

Flame Spread Index and Smoke Developed Index, Classification B

5-ply 130 mm thick CLT, SwRI Project No. 01.23472.02.001, April 17, 2018

ASTM E2768-11 STANDARD TEST METHOD FOR EXTENDED DURATION SURFACE BURNING CHARACTERISTICS OF BUILDING MATERIALS (30 MIN TUNNEL TEST)

Flame Spread Index and Smoke Developed Index, Classification B

5-ply 130 mm thick CLT, SwRI Project No. 01.23472.02.001a

Support during erection

Single Family house in Klagenfurt | Austria

Home in Scappoose, Oregon | USA

09 GENERAL STRUCTURAL NOTES

01 Cross-Laminated Timber panels shall be manufactured in accordance with the latest edition of ANSI/APA PRG 320, Standard for Performance-Rated Cross-Laminated Timber.

02 Minimum Limit States Design (LSD) properties for the lumber laminations used in the panels shall be grade CV3M1.

03 Exposed panel surfaces shall be finished as per the Architectural drawings.

04 Contractor to confirm all dimensions and details with Architectural drawings.

05 CLT panels shall consist of 3, 5, 7, or 8 layers of crosswise stacked spruce boards and glued together with approved adhesives. Lamination thickness may vary from 20 mm to 40 mm.

06 Panels shall not be fabricated until approval of the shop drawings by the E.O.R.

07 Panels shall be manufactured with lumber of maximum moisture content of 12% (+/-) 2%.

08 The Contractor shall cut no holes, slots, notches, grooves, etc. in the panels without written approval by the E.O.R.

09 CLT panels shall be installed in strict conformance with manufacturer's requirements

10 Store all panels off the ground and stacked using spacers to separate individual panels. Contractor is responsible for taking appropriate measures to minimize the likelihood of staining, cracking, distortion, warping or other types of damage to the panels.

11 Lift and support panels during construction only at designated points shown in the shop drawings.

12 Handle panels consistent with their shape to minimize damage.

13 Panels shall fit together properly, without trimming or cutting in the field. The Contractor shall report any problems with fit-up to the E.O.R.

14 CLT panels shall be adequately braced until all structural diaphragms and permanent bracing systems are installed and connected per the EOR.

15 Floor and roof panels shall be oriented with the exterior layers perpendicular to the supports, U.N.O.

16 Structural steel components used to connect CLT panels to each other and/or to the structural framework, if supplied by the manufacturer, shall be test fitted in the manufacturing facility prior to shipment.

17 The manufacturer shall provide instructions and prepare the panels for shipment in such a way as to facilitate erection.

18 Manufacturer shall label all panels.

19 Panel labels shall include information on the surface qualities of each face.

20 Manufacturer shall submit product certificates to the A.O.R. and E.O.R. for review and written approval prior to fabrication.

10 SECTION 06 18 00 GLUED-LAMINATED CONSTRUCTION

Note: although the following specification section pertains to both glued-laminated members as well as cross laminated timber (CLT) panels, the basic provisions noted below focus on CLT only.

PART 1 GENERAL

1.1 SECTION INCLUDES

A Glued-laminated (Glulam) beams and columns, as well as cross laminated timber (CLT) panels as shown on Drawings.

1.2 RELATED SECTIONS

A Section 01 33 00 – Submittal Procedures
B Section 06 10 53 – Miscellaneous Rough Carpentry

1.3 REFERENCES

A ANSI/APA PRG 320, Standard for Performance-Rated Cross-Laminated Timber.
B CSA O86, Engineering Design in Wood.
C CSA O112 SERIES-M1977 (R2006), CSA Standards for Wood Adhesives.
D National Building Code of Canada with applicable Provincial Building Code and City Building By-law.
E All codes and standards are to be the current adopted editions.

1.4 DESIGN

A Structural design shall be conducted by a Professional Engineer for all CLT-to-CLT connections not already detailed on Drawings.

1.5 SUBMITTALS

A Section 01 33 00: Submittal Procedure.
B Product data for each type of product indicated.
C Shop Drawings, including panel location plans, dimensions, shapes and sections, openings, support conditions, and connections.
   1 Indicate lifting connections.
   2 Indicate locations, tolerances, and details of anchorage to supporting structure.
   3 Include and locate openings.
   4 Indicate location of CLT panel by identification mark placed on panel.
   5 Indicate relationship of CLT panels to adjacent materials.
   6 Clearly indicate stress grade, service grade, and appearance grade of surfaces.
   7 Provide three dimensional models of all interfaces and CLT panels, including all connections.
   8 CLT supplier shall provide a fully accurate three-dimensional (3D) model of the interfaces (supports, abutments, etc.), CLT panels, and all connections prior to submission of shop drawings. Model to be generated using hsbcad (compatible with AutoCAD 2011).
D Sustainable design submittals.
   1 Manufacturer's product data for adhesives, sealants, paints, and coatings, including printed manufacturer's statement of VOC content.
   2 Provide certificates indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material to Project, by rail, by inland waterway, by sea and by all other means. Include statement indicating cost for each regional material, and fraction by weight that is considered regional.
   3 For non-recycled wood and wood-based materials, provide itemized list of materials including manufacturer and vendor chain-of-custody certificates. Vendors and organizations modifying materials and/or packaging of materials must be FSC Chain of Custody (CoC) certified, as determined by an FSC-accredited certification body.
   4 Certified Wood: Lamination stock shall be produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."
   5 As an alternate, CLT lumber shall be certified to PEFC.

1.6 QUALIFICATIONS

A Cross laminated timber manufacturer shall conform to the latest approved edition of ANSI/APA PRG 320.
B All material certificates shall be submitted in accordance with CAN/CSA O177.

1.7 DELIVERY, STORAGE, AND HANDLING

A Support panels during shipment on non-staining material in same position as during storage.
B Store panels with adequate bracing and protect panels to prevent contact with soil. Separate panels with blocking so that air may circulate around all faces. Take all reasonable steps to prevent cracking, distortion, warping or other physical damage.
   1 Place stored panels so that identification labels are clearly visible.
   2 Handle and transport units in a position consistent with their shape and design to avoid excessive stresses that would cause cracking or damage.
   3 Lift and support panels only at designated points shown on the Shop Drawings.
   4 Cover top and sides with opaque moisture resistant membrane.
   5 Maintain protection of panels at all times during construction.

PART 2 PRODUCTS

2.1 MATERIALS

A Provide FSC® C119602-certified wood products, or a PEFC alternative.
B Wood Species: Spruce for lamination stock for panels.
C CLT adhesive: Provide adhesive products in compliance with ANSI A190.1, DIN 68141, and EN301 and EN302.
1 Acceptable Product: Purbond HB X172 by Henkel Corp.
D Basis-of-Design manufacturer: KLH Massivholz GmbH

2.2 ACCESSORIES

A Supplier to supply all CLT fasteners.

2.3 FABRICATION

A Fabricate panels in accordance with ANSI/APA PRG 320. Use multiple layers of 20 mm minimum to 40 mm maximum thick laminations.
B Manufacturer to be ISO 9001, 14001, and 50001 certified.
C CLT Layup shall be Stress Grade CV3M1 as per Product listing.
D Joints: CLT panels shall be joined at panel edges using connections as indicated on the Drawings.
E CLT shall be delivered to the project site at 12% moisture content (±2%)
F Tolerances: +/- 2 mm for panels >1 m^2 @ 12% moisture content.

2.4 FINISHES

A Panels shall satisfy one of the following appearance classifications, as indicated on the Drawings.
See www.klh.at/en/product/surface/ for a complete description of these classifications.
1 NSI (NVQ): Non-Visual Quality (very low surface quality, planed)
2 ISI (IVQ): Industrial Visual Quality (medium surface quality, sanded)
3 WSI (DVQ): Domestic Visual Quality (high surface quality, sanded, surface edges glued)

PART 3 EXECUTION

3.1 EXAMINATION

A Prior to fabrication, check all dimensions relating to this section of work. Report any discrepancies to the EOR.
B Prior to site erection, examine all site conditions and ensure an acceptable condition.

3.2 ERECTION

A Erect panels in accordance with final approved shop drawings.
B Make adequate provision for possible erection stresses. Set panels level and plumb to correct positions. Securely brace panels and anchor in place to maintain plumb until permanently secured by finished structure.
C Fit panels closely and accurately, without trimming, cutting, or other modifications, unless approved in writing by the EOR.
D Site cutting or boring of panels, other than shown on the shop drawings, is not permitted without the written consent of the EOR.

3.3 CLEAN-UP

A Clean exposed surface of panels after erection and completion of field touch up.
B Perform cleaning procedures, if necessary, according to Manufacturer's written recommendations. Protect other work from staining or damage due to cleaning operations.
C Do not use cleaning materials or processes that could damage the appearance of the panels or damage adjacent materials.

END OF SECTION 06 18 00

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