NORDIC ENGINEERED WOOD

NON-RESIDENTIAL DESIGN

CONSTRUCTION GUIDE

NORDIC X-LAM™

NORDIC ENGINEERED WOOD

FSC-CERTIFIED PRODUCTS AVAILABLE

FSC
www.fsc.org

The mark of responsible forestry

FSC® C011517

NORDIC
ENGINEERED WOOD

BRINGING NATURE'S RESOURCES HOME

Nordic Engineered Wood was founded in the year 2000 to develop and promote high-quality wood products for use in residential and non-residential construction.

Our vision is built on the founding principles of reliable service, consistent quality, and responsible forestry practices. Chantiers Chibougamau Ltd (CCL) has achieved FSC certification, the international certification system dedicated to promoting responsible management of the forests, to ensure the long term viability of our precious natural resources.

The manufacture of cross-laminated timber, with an annual production capacity of 80,000 cubic meters, is a natural addition to the Nordic product range, especially the glulam. Nordic Engineered Wood's goal is to provide the most consistent, high-quality finished products available. The Nordic X-Lam family of products illustrates our continued passion for building on tradition.

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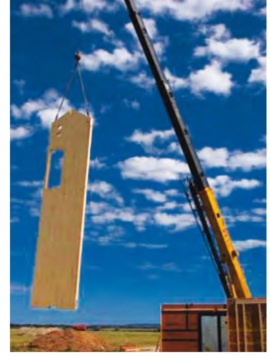
THE ADVANTAGES
OF WOOD CONSTRUCTION



SUSTAINABLE

Wood is the only construction material that is 100% natural, renewable and recyclable. Because it sequesters carbon and can replace more energy-intensive and polluting materials like steel and concrete, choosing wood contributes to the fight against climate change. What's more, Nordic cross-laminated timber comes from forests with FSC Forest Management certification, which ensures that natural resources are protected.

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ARCHITECTURALLY INNOVATIVE

Cross-laminated timber can define the spatial dimensions of a structure while simultaneously bearing loads, thereby providing new possibilities for walls, floors and roofs. A monolithic material with superior load-bearing properties, mass timber panels can easily accommodate added architectural features, particularly open corners, cantilever elements and free-form openings. Not only is cross-laminated timber the ideal choice for energy-efficient and resource-conscious projects, it is also a perfect way to incorporate natural materials into cutting-edge architectural designs.

RELIABLE

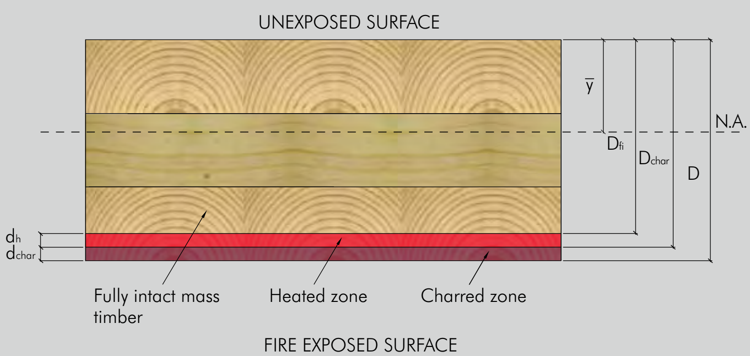
The remarkable structural resistance of cross-laminated timber makes it suitable for single- and multiple-unit residences and public buildings as well as offices, schools, and industrial and commercial projects. An increasingly popular choice due to its load-bearing properties and its exceptional quality, cross-laminated timber is ideal for use in multi-story buildings, composite wood systems and many different types of structures.

FIRE RESISTANT

Fire resistance refers to the ability of a material to maintain its fire-separating function and structural strength when exposed to flames. High fire resistance improves a building's safety and enables evacuation. When mass timber burns, a layer of char forms at its surface and protects the unburned wood underneath, leaving its mechanical properties intact. Unlike in the case of many "non-combustible" building materials, the mechanical resistance of wood is largely unaffected by heat.

Mass timber behaves in a predictable manner when exposed to fire, allowing fire resistance to be determined during the design phase. Because cross-laminated timber has a proven nominal char rate of 1.5 in. per hour, designers can specify minimum dimensions that will ensure that the mechanical performance of the timber can withstand exposure to fire in accordance with the desired fire-resistance rating.

CROSS SECTION OF FIRE-EXPOSED CROSS-LAMINATED TIMBER



A SUSTAINABLE
ALTERNATIVE

INNOVATIVE CONSTRUCTION

Cross-laminated timber is a sustainable alternative to steel and concrete. Lightweight and easy to use, Nordic X-Lam has a smaller ecological footprint than that of other building materials, making it the ideal choice for sustainable and environmentally responsible construction. Nordic X-Lam's design properties also provide it with exceptional fire resistance, shear strength and load-bearing capacity.

HEALTH AND WELLNESS

Two factors must be taken into account when attempting to understand and improve upon our built environment. The first is air quality, an issue of increasing importance that is still too often ignored. The second is acoustics, which are greatly influenced by the materials used for certain building components. Cross-laminated timber is the ideal choice for creating calm and quiet spaces.

BUILDING THE FUTURE

Cross-laminated timber is transforming the construction industry that has enabled the adoption of a more efficient and environmentally responsible construction process. What's more, the increased prevalence of structures made from cross-laminated timber, which is much less carbon-emitting than traditional building materials like concrete and steel, has a positive impact on the environment.

Ushering in a new era of design and construction, cross-laminated timber is a sustainable and environmentally responsible industry trend that has yet to reach its full potential.

The World Health Organization (WHO) has long defined health as "*a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity.*"

Health is a multi-faceted issue that greatly affects quality of life. Physical health, mental well-being, and the quality of one's interactions with one's environment are all factors in overall health.

When viewed from this perspective, the importance of improving upon the built environment and developing strategies for the creation of comfortable living spaces becomes extremely clear.

For our FSC Chain of Custody certificate, see:
http://nordic.ca/en/documentation/technical-documents/ra-coc-004084

For our Environmental Product Declaration, see:
http://nordic.ca/en/documentation/technical-documents/epd-xl

VISUAL
CHARACTERISTICS

APPEARANCE GRADES

The following examples of CLT appearance classifications are for reference only. These requirements are based on the appearance at the time of manufacturing. The actual CLT panel appearance requirements are recommended to be agreed upon between the buyer and the seller.

Industrial Appearance
An appearance classification normally suitable for use in concealed applications where appearance is not of primary concern. Specific characteristics of this classification are as follows:
- Voids appearing on the edges of laminations need not be filled.
- Loose knots and knot holes appearing on the face layers exposed to view are not filled.
- Members are surfaced on face layers only and the appearance requirements apply only to these layers.
- Occasional misses, low laminations or wane (limited to the lumber grade) are permitted on the surface layers and are not limited in length.

Industrial Appearance Grade

Architectural Appearance
An appearance classification normally suitable for applications where appearance is an important but not overriding consideration. Specific characteristics of this classification are as follows:
- In exposed surfaces, all knot holes and voids measuring over 3/4 inch are filled with a wood-tone filler selected for similarity with the grain and color of the adjacent wood.
- The face layers exposed to view are free of loose knots and open knot holes are filled.
- Knot holes do not exceed 3/4 inch when measured in the direction of the lamination length with the exception that a void may be longer than 3/4 inch if its area is not greater than 1/2 in.[2].
- Voids greater than 1/16 inch wide created by edge joints appearing on the face layers exposed to view are filled.
- Exposed surfaces are surfaced smooth with no misses permitted.

Architectural Appearance Grade

SPECIFICATION
GUIDE

CROSS-LAMINATED CONSTRUCTION

The following is a guide for preparing specifications for structural cross-laminated timber used for floor or roof slabs, or wall panels.

1. GENERAL

1. Structural cross-laminated timber shall be furnished as shown on the plans and in accordance with the following specifications. (Where other uses or requirements are applicable, modify specifications accordingly.)
2. For custom-designed members, shop drawings and details shall be furnished by the manufacturer and approval obtained from the (architect) (engineer) (general contractor) and (buyer) before fabrication begins.
3. The manufacturer shall furnish connection steel and hardware for joining structural cross-laminated timber members to each other and to their supports, exclusive of anchorage embedded in masonry or concrete, setting plates and items field-welded to structural steel. Steel connections shall be finished with one coat of rust-inhibiting paint.

2. MANUFACTURE

1. **Materials, Manufacture and Quality Assurance –** Structural cross-laminated timber of softwood species shall be in conformance with ANSI/APA PRG 320, *Standard for Performance-Rated Cross-Laminated Timber.*
2. **Design Values –** Structural cross-laminated timber shall provide design values for normal load duration and dry-use condition. The design should specify a layup combination (E1 grade).
3. **Appearance Grade –** Structural cross-laminated timber shall be (industrial) or (architectural) grade in accordance with ANSI/APA PRG 320.
4. **Laminating Adhesives –** Adhesives used in the manufacture of structural cross-laminated timber shall meet the requirements for dry-use service conditions.
5. **Fire Resistance *(when applicable)* –** Structural cross-laminated timber shall be sized and manufactured for one-hour fire resistance, or as required.
6. **Protective Sealers and Finishes –** Surfaces of members shall be (not sealed) (sealed with primer/sealer coating).
7. **Trademarks –** Members shall be marked with the APA EWS trademark indicating conformance with the manufacturing, quality assurance and marking provisions of ANSI/APA PRG 320.
8. **Certificates *(when applicable)* –** A Certificate of Conformance may be provided by the manufacturer to indicate conformance with ANSI/APA PRG 320 if requested.
9. **Protection for Shipment –** Members shall be bundle wrapped with a water-resistant covering for shipment.

For complete specification guide:
http://nordic.ca/en/documentation/technical-documents/t-t09

For APA Product Report:
http://nordic.ca/en/documentation/technical-documents/apa-pr-l306

DESIGN

Floor and roof slabs

Cross-laminated timber ("CLT") panels are typically designed in single direction, which results in most cases in a conservative solution. The designer must ensure to use an appropriate deflection criteria and consider the effects of floor vibration when applicable

Shearwalls and diaphragms

Capacity design principles are recommended for design of CLT for seismic resistance to ensure predictable yielding in CLT wall panels and interconnection of CLT elements through fastener yielding, wood crushing, or a combination thereof prior to onset of undesirable brittle wood failure modes. For more details refer to Chapter 4 of CLT Handbook, U.S. Edition.

Wall panels

Only the layers parallel to the axial load shall be taken into account. The shear capacities for shearwalls and lintels are based on a reseach project at the Graz University of Technology. *(Ref. Bogensperger T., Moosbrugger T., Silly G., Verification of CLT-plates under loads in plane. WCTE 2010)*

Lintels

CLT elements under axial in-plane loads acting as deep beams or lintels may be designed using the capacities shown below and an effective cross-section based on the layers perpendicular to the load.

Duration of load

It is recommended to use the load duration factor, C_D, for ASD as specified in Table 2.3.2 of ANSI/AWC NDS-2012.

Creep

The current factor specified in ANSI/AWC NDS-2012 does not account for creep that may occur in CLT. Therefore, the time dependent deformation (creep) factor K_{cr} = 2.0 is recommended for dry service conditions. These factors have been considered in the selection tables.

Deflection

The designer is advised to check the elastic deflection and permanent deformation for CLT slab elements as to not exceed the total load deflection limit in the code (Table 1604.3 of the 2012 IBC).

Vibration

The designer is advised to check the maximum floor vibrations for CLT slab elements. The proposed design method for controlling vibrations in CLT floors is based on a research project at the Technical University of Munich. *(Ref. Hamm P.,Richter A., Winter S. Floor vibrations - new results. WCTE 2010)*

Fire resistance

The fire-resistance rating of CLT panels can be calculated using the reduced (or effective) cross-section method and the use of the published design values. For more details refer to Chapter 8 of CLT Handbook, U.S. Edition, or use Nordic Sizer software.

MATERIAL DESIGN PROPERTIES

STRESS GRADE	E1	
ORIENTATION	LONGITUDINAL	TRANSVERSAL
SPECIES GROUP	S-P-F	S-P-F
STRESS CLASS	1950f MSR	No. 3
Bending at extreme fiber, F_b (psi)	1950	500
Shear parallel to grain, F_v (psi)	135	135
Rolling shear, F_s (psi)	45	45
Compression parallel to grain, F_c (psi)	1800	650
Compression perp. to grain, F_{cp} (psi)	425	425
Tension parallel to grain, F_t (psi)	1375	250
Modulus of elasticity, E_0 (psi)	1,700,000	1,200,000
Shear modulus, G_0 (psi)	106,250	75,000
Rolling shear modulus, G_s (psi)	10,625	7500

DESIGN PROPERTIES
SLABS

DESIGN PROPERTIES – floor/roof slabs

APPLICATION	FLOOR AND ROOF SLABS						
APPEARANCE GRADES	INDUSTRIAL OR ARCHITECTURAL						
STRESS GRADE	E1 (L 1950F_b and T No. 3/Stud)						
LAYUP COMBINATIONS	78-3s	105-3s	131-5s	175-5s	220-7s	244-7l	314-9l
Bending about the major strength axis							
Bending moment, M_0 (lbf-ft/ft)	2525	4525	5800	10,400	15,975	23,700	36,700
Shear, V_0 (lbf/ft)	1070	1430	1470	1970	2400	3200	3875
Bending rigidity, $EI_{eff,0}$ (10^6 lbf-in.^{2}/ft)	48	115	184	440	853	1404	2794
Shear rigidity, $GA_{eff,0}$ (10^6 lbf/ft)	0.34	0.46	0.69	0.92	1.4	2.0	2.4
Bending about the minor strength axis							
Bending moment, M_{90} (lbf-ft/ft)	95	160	785	1370	2160	1370	3125
Shear, V_{90} (lbf/ft)	380	495	1090	1430	1580	1430	1960
Bending rigidity, $EI_{eff,90}$ (10^6 lbf-in.^{2}/ft)	1.4	3.1	35	81	184	81	309
Shear rigidity, $GA_{eff,90}$ (10^6 lbf/ft)	0.47	0.61	0.94	1.2	1.5	1.9	2.5

(1) The design of cross-laminated timber members shall be in accordance to NDS, 2015 Edition. Chapter 16 establishes general fire design provisions
(2) The tabulated design values are for dry service conditions of use and normal duration of loading.
(3) Nordic X-Lam bending panels are symmetrical throughout the depth of the member (balanced layups).
(4) The compression perpendicular to grain values shall be based on S-P-F No. 3 lumber (f_{cp} = 425 psi).
(5) The capacities were derived analytically using the shear analogy model[1] and validated by testing (the calculated moment capacities in the major strength axis were further multiplied by a factor of 0.85 for conservatism).
(6) The specific gravity for dowel-type fastener design is 0.41. Member weight shall be based on density of 32 pcf.

** Nordic X-Lam products are certified by APA (Product Report PR-L306), per the ANSI/APA PRG 320 Standard[2].*

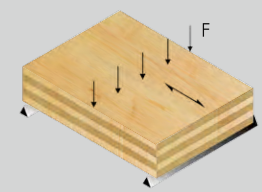
[1] *Karacabeyli, E. and B. Douglas. 2013. CLT Handbook, U.S. Edition. FPInnovations, Canada. http://www.masstimber.com/products/cross-laminated-timber-clt/handbook/modules*

PANEL LAYUPS

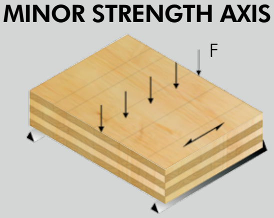
PRODUCT	COMPOSITION (L = longitudinal, T = transversal)	NUMBER OF PLIES	THICKNESS (mm)	THICKNESS (in.)	WEIGHT (psf)
78-3s	26L - 27T - 26L	3	78	3-1/8	8.33
105-3s	35L - 35T - 35L	3	105	4-1/8	11.0
131-5s	26L - 27T - 26L - 27T - 26L	5	131	5-1/8	13.7
175-5s	35L - 35T - 35L - 35T - 35L	5	175	6-7/8	18.3
220-7s	35L - 27T - 35L - 27T - 35L - 27T - 35L	7	220	8-5/8	23.0
244-7l	35L - 35L - 35T - 35L - 35T - 35L - 35L	7	244	9-5/8	25.7
314-9l	35L - 35L - 35T - 35L - 35T - 35L - 35T - 35L - 35L	9	314	12-3/8	33.0

NOTE: The grade designation refers to the panel thickness (in mm), the number of layers, and the layup combination ("s" for standard perpendicular layers, and "l" for doubled outermost parallel layers).

BENDING ABOUT THE MAJOR STRENGTH AXIS



BENDING ABOUT THE MINOR STRENGTH AXIS



For the ANSI/APA PRG 320 Standard:
http://www.apawood.org/pdfs/download_pdf.cfm?PDFFilename=managed/PRG_320-2012.pdf

For the APA Product Report:
http://nordic.ca/en/documentation/technical-documents/apa-pr-l306

FLOOR/ROOF
SLABS

To verify that the Slab Selection Tables are appropriate for the structure being designed, the following questions should be asked (the appropriate adjustment factor is given in brackets):

1. **Is load duration "normal" (C_D)?**
   C_D is a load duration factor. The tables are based on a normal duration of loading (C_D = 1.0), which includes the effects of dead loads plus live loads due to use and occupancy, and snow loads.

2. **Is the service condition "dry" (C_M)?**
   C_M is a wet service factor. The tables are limited to dry service conditions (C_M = 1.0).

3. **Are the applicable total load and live load deflection limits based on L/240 and L/360, respectively?**
   The tables are based on deflection limits of span/240 under design total load and span/360 under design live load. For other deflection limits, multiply the values accordingly.

4. **Should floor vibration be considered?**
   The designer is advised to check the maximum floor vibrations for CLT slab elements. The proposed design method for controlling vibrations in CLT floors is based on a research project at the Technical University of Munich. See allowable floor spans on page 16.

5. **Should creep effects be considered?**
   The time dependent deformation (creep) factor K_{cr} = 2.0 is recommended for dry service conditions. This factor has been considered in the selection tables.

6. **Is the loading uniform?**
   The tables are based on uniform loads. In some applications, floor or roof slabs may have to be designed for a concentrated live load (as defined in article 1607.4 of the 2012 IBC) or other non-uniform loading. In these cases refer to NDS-2012 and the CLT Handbook, U.S. Edition.

If the answer to any of those questions is no, consult Nordic. Otherwise, the Slab Selection Tables may be used directly. The selection tables provide the maximum uniform design total or live load, w_Δ, that may be applied to a panel to ensure that the design criteria are met.

Note: The tables are based on standard depths for bending about the major strength (strong) axis of the panel. The slab self weight has not been considered in the calculation of maximum loads (i.e. it shall be included in the design total load). Consult Nordic for other options.

SLABS
SIZING

L/240, TOTAL LOAD DEFLECTION CRITERIA
SLAB THICKNESS (in.)

<table>
<tr><th rowspan="2">TL (psf)</th><th colspan="7">SIMPLE SPAN</th><th colspan="7">DOUBLE SPAN</th></tr>
<tr><th>10 ft</th><th>12 ft</th><th>14 ft</th><th>16 ft</th><th>18 ft</th><th>20 ft</th><th>22 ft</th><th>10 ft</th><th>12 ft</th><th>14 ft</th><th>16 ft</th><th>18 ft</th><th>20 ft</th><th>22 ft</th></tr>
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<tr><td>100</td><td rowspan="7">4 1/8</td><td rowspan="7">6 7/8</td><td rowspan="7">6 7/8</td></tr>
<tr><td>110</td></tr>
<tr><td>120</td><td rowspan="6">8 5/8</td><td rowspan="5">5 1/8</td></tr>
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<tr><td>140</td><td rowspan="3">5 1/8</td><td rowspan="3">6 7/8</td><td rowspan="3">4 1/8</td></tr>
<tr><td>150</td></tr>
<tr><td>160</td><td>8 5/8</td><td>8 5/8</td></tr>
</table>

L/360, LIVE LOAD DEFLECTION CRITERIA
SLAB THICKNESS (in.)

<table>
<tr><th rowspan="2">TL (psf)</th><th colspan="7">SIMPLE SPAN</th><th colspan="7">DOUBLE SPAN</th></tr>
<tr><th>10 ft</th><th>12 ft</th><th>14 ft</th><th>16 ft</th><th>18 ft</th><th>20 ft</th><th>22 ft</th><th>10 ft</th><th>12 ft</th><th>14 ft</th><th>16 ft</th><th>18 ft</th><th>20 ft</th><th>22 ft</th></tr>
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<tr><td>120</td></tr>
<tr><td>130</td><td rowspan="4">5 1/8</td><td rowspan="4">6 7/8</td></tr>
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<tr><td>150</td><td rowspan="2">5 1/8</td><td rowspan="2">8 5/8</td><td rowspan="2">9 5/8</td><td rowspan="2">8 5/8</td></tr>
<tr><td>160</td><td>9 5/8</td></tr>
</table>

NOTES:

1. Sizing (panel thickness shown in inches) based on « E1 » stress grade and the correspondance below. The product designation refers to the panel thickness (in mm), the number of layers, and the layup combination ("s" for standard cross layers, and "l" for doubled outermost longitudinal layers). → 78-3s (3-1/8 in.), 105-3s (4-1/8 in.), 131-5s (5-1/8 in.), 175-5s (6-7/8 in.), 220-7s (8-5/8 in.), 244-7l (9-5/8 in.), and 314-9l (12-3/8 in.)
2. For preliminary design use only. The design is based on NDS-2012 and the CLT Handbook, U.S. Edition. Final design shall include a complete analysis including the verification of the bearing capacity, a consideration for floor vibration if applicable, and fire safety requirements.
3. Tables are based on uniform loads, dry-use conditions and normal duration of loading, for bending about the major strength axis of the panel. Span is measured center to center of supports.
4. The loads indicated above are the uniform design total load (TL) or live load (LL). The panels weight is not considered and shall be included in the design total load calculation.
5. Maximum deflection = L/240 under total load or L/360 under live load. Other deflection limits may apply. A time dependent deformation (creep) factor, K_{cr}, of 2.0 is recommended when checking the permanent deformation in order to account for creep effects.

SELECTION TABLES

L/240 DEFLECTION LIMIT, SIMPLE SPAN

ALLOWABLE UNIFORM TOTAL LOAD $W_{\Delta R}$ (psf)

SPAN (ft)	LAYUP COMBINATION						
	78-3s	105-3s	131-5s	175-5s	220-7s	244-7l	314-9l
10.0	97.5	219					
10.5	84.9	192					
11.0	74.4	169	268				
11.5	65.5	149	237				
12.0	57.9	133	211				
12.5	51.5	118	188				
13.0		106	168				
13.5		95.2	151				
14.0		85.8	137	306			
14.5		77.7	124	278			
15.0		70.5	112	254			
15.5		64.2	102	232			
16.0		58.6	93.3	212			
16.5		53.6	85.4	195			
17.0			78.4	179	338		
17.5			72.1	165	312		
18.0			66.5	153	289		
18.5			61.4	141	268		
19.0			56.8	131	248		
19.5			52.7	122	231		
20.0				113	215	349	
20.5				105	201	326	
21.0				98.5	187	305	
21.5				92.0	175	285	
22.0				86.2	164	267	
22.5				80.8	154	251	
23.0				75.8	145	236	
23.5				71.2	136	222	
24.0				67.0	128	209	396
24.5				63.1	121	197	374
25.0				59.5	114	186	353
25.5				56.2	108	176	335
26.0				53.1	102	166	317
26.5					96.3	157	300
27.0					91.2	149	285

NOTE:

1. A complete design shall include the verification of the capacity, a consideration for creep and floor vibration when applicable (in this case, refer to page 16 for the allowable spans), and fire safety requirements.

E1

L/240 DEFLECTION LIMIT, DOUBLE SPAN

ALLOWABLE UNIFORM TOTAL LOAD $W_{\Delta R}$ (psf)

SPAN (ft)	LAYUP COMBINATION						
	78-3s	105-3s	131-5s	175-5s	220-7s	244-7l	314-9l
10.0	137						
10.5	119	268					
11.0	105	236					
11.5	92.2	209					
12.0	81.6	186	295				
12.5	72.6	166	264				
13.0	64.8	149	236				
13.5	58.1	134	213				
14.0	52.3	121	192				
14.5		109	174				
15.0		99.2	158				
15.5		90.3	144	325			
16.0		82.5	131	298			
16.5		75.5	120	273			
17.0		69.3	110	252			
17.5		63.7	102	232			
18.0		58.7	93.7	214			
18.5		54.3	86.5	199			
19.0			80.1	184	349		
19.5			74.3	171	324		
20.0			69.0	159	302		
20.5			64.2	148	282		
21.0			59.9	139	263		
21.5			55.9	130	246		
22.0			52.3	121	231	375	
22.5			48.9	114	217	352	
23.0			45.9	107	204	331	
23.5			43.1	100.4	191	312	
24.0			40.5	94.4	180	294	
24.5			38.1	89.0	170	277	
25.0				83.9	160	261	
25.5				79.2	152	247	
26.0				74.9	143	234	
26.5				70.9	136	221	
27.0					129	210	400

NOTE:

1. A complete design shall include the verification of the capacity, a consideration for creep and floor vibration when applicable (in this case, refer to page 16 for the allowable spans), and fire safety requirements.

E1

L/360 DEFLECTION LIMIT, SIMPLE SPAN

ALLOWABLE UNIFORM LIVE LOAD $W_{\Delta R}$ (psf)

SPAN (ft)	LAYUP COMBINATION						
	78-3s	105-3s	131-5s	175-5s	220-7s	244-7l	314-9l
10.0	65.0	146					
10.5	56.6	128					
11.0	49.6	113	179				
11.5	43.7	99.5	158				
12.0	38.6	88.4	140				
12.5	34.3	78.8	125				
13.0	30.7	70.6	112				
13.5	27.5	63.4	100.9				
14.0	24.7	57.2	91.1	204			
14.5	22.3	51.8	82.4	186			
15.0	20.2	47.0	74.9	169			
15.5		42.8	68.2	155			
16.0		39.1	62.2	142	266		
16.5		35.7	57.0	130	245		
17.0		32.8	52.3	119	226		
17.5		30.1	48.1	110	208		
18.0		27.8	44.3	102	193		
18.5		25.7	40.9	94.2	178		
19.0		23.7	37.9	87.3	166	268	
19.5		22.0	35.1	81.1	154	250	
20.0		20.4	32.6	75.5	143	233	
20.5			30.4	70.3	134	217	
21.0			28.3	65.6	125	203	
21.5			26.4	61.4	117	190	
22.0			24.7	57.4	109	178	
22.5			23.1	53.8	103	167	
23.0			21.7	50.5	96.5	157	
23.5			20.3	47.5	90.7	148	
24.0				44.7	85.4	139	264
24.5				42.1	80.5	131	249
25.0				39.7	75.9	124	236
25.5				37.5	71.7	117	223
26.0				35.4	67.8	111	211
26.5				33.5	64.2	105	200
27.0				31.7	60.8	99.3	190

NOTE:

1. A complete design shall include the verification of the capacity, a consideration for creep and floor vibration when applicable (in this case, refer to page 16 for the allowable spans), and fire safety requirements.

E1

L/360 DEFLECTION LIMIT, DOUBLE SPAN

ALLOWABLE UNIFORM LIVE LOAD $W_{\Delta R}$ (psf)

SPAN (ft)	LAYUP COMBINATION						
	78-3s	105-3s	131-5s	175-5s	220-7s	244-7l	314-9l
10.0	91.3						
10.5	79.6	179					
11.0	69.7	158					
11.5	61.4	139					
12.0	54.4	124					
12.5	48.4	111	176				
13.0	43.2	99.2	158				
13.5	38.7	89.2	142				
14.0	34.9	80.5	128				
14.5	31.5	72.8	116				
15.0	28.5	66.1	105				
15.5	25.9	60.2	95.9	217			
16.0	23.6	55.0	87.6	198			
16.5	21.6	50.3	80.2	182			
17.0		46.2	73.6	168			
17.5		42.5	67.7	155			
18.0		39.2	62.4	143	270		
18.5		36.2	57.7	132	250		
19.0		33.5	53.4	123	232		
19.5		31.0	49.5	114	216		
20.0		28.8	46.0	106	201		
20.5		26.8	42.8	99.0	188		
21.0		25.0	39.9	92.4	176		
21.5		23.3	37.3	86.4	164	267	
22.0		21.8	34.8	80.9	154	250	
22.5		20.4	32.6	75.8	144	235	
23.0			30.6	71.2	136	221	
23.5			28.7	66.9	128	208	
24.0			27.0	63.0	120	196	
24.5			25.4	59.3	113	185	
25.0			24.0	56.0	107	174	
25.5			22.6	52.8	101	165	
26.0			21.3	49.9	95.5	156	
26.5			20.2	47.3	90.4	148	
27.0				44.8	85.7	140	267

NOTE:

1. A complete design shall include the verification of the capacity, a consideration for creep and floor vibration when applicable (in this case, refer to page 16 for the allowable spans), and fire safety requirements.

E1

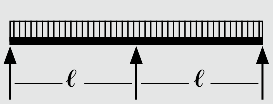
SERVICEABILITY – VIBRATION CRITERIA
30 PSF DEAD LOAD
ALLOWABLE SPANS ℓ_{max} (ft)

RATIO	COMBINATION						
	78-3s	105-3s	131-5s	175-5s	220-7s	244-7l	314-9l
ENHANCED CRITERIA							
Ratio 1:1	6'-7"	10'-2"	15'-11"	19'-4"	22'-3"	24'-11"	28'-8"
Ratio 1:2	6'-7"	10'-2"	16'-5"	21'-9"	25'-1"	28'-1"	32'-4"
Ratio 1:3	6'-7"	10'-2"	16'-5"	22'-3"	25'-8"	28'-9"	33'-1"
ENHANCED CRITERIA							
Ratio 1:1	4'-8"	7'-2"	11'-7"	16'-9"	19'-3"	21'-7"	24'-10"
Ratio 1:2	4'-8"	7'-2"	11'-7"	17'-10"	21'-9"	24'-4"	28'-0"
Ratio 1:3	4'-8"	7'-2"	11'-7"	17'-10"	22'-3"	24'-11"	28'-8"

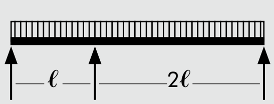
SERVICEABILITY – VIBRATION CRITERIA
50 PSF DEAD LOAD
ALLOWABLE SPANS ℓ_{max} (ft)

RATIO	COMBINATION						
	78-3s	105-3s	131-5s	175-5s	220-7s	244-7l	314-9l
ENHANCED CRITERIA							
Ratio 1:1	6'-7"	10'-2"	14'-6"	17'-9"	20'-7"	23'-1"	26'-9"
Ratio 1:2	6'-7"	10'-2"	16'-4"	20'-0"	23'-2"	26'-0"	30'-2"
Ratio 1:3	6'-7"	10'-2"	16'-5"	20'-5"	23'-8"	26'-7"	30'-11"
ENHANCED CRITERIA							
Ratio 1:1	4'-8"	7'-2"	11'-7"	15'-4"	17'-10"	20'-0"	23'-2"
Ratio 1:2	4'-8"	7'-2"	11'-7"	17'-3"	20'-1"	22'-6"	26'-2"
Ratio 1:3	4'-8"	7'-2"	11'-7"	17'-8"	20'-6"	23'-1"	26'-9"

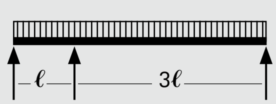
NOTES:
1. The allowable spans are based on a dead load of 30 or 50 psf in addition to the panel self weight.
2. The ratios represent the span ratios (see figures below). For a simple span, use a ratio of 1:1.
3. The allowable spans are based on Hamm-Richter-Winter design method to control floor vibrations and take into account the following assumptions: live load neglected in the calculation of the mass, panels supported on both sides, damping factor of 1.0%.
4. It should be noted that floor vibrations evaluation is subjective, and that other floor compositions and bearing conditions may increase the floor performance.
5. The allowable spans only consider the floor vibration criteria.



Ratio 1:1



Ratio 1:2



Ratio 1:3

EXAMPLE: **ROOF SLAB**

Roof slab

Given a slab of 4-1/8 in. (105-3s); self weight = 11 psf
Design dead load = 40 psf (including slab self weight)
Design dead load (for creep effects) = 2.0 x 40 = 80 psf
Design snow load = 30 psf
Beam spacing (span) = 15.5 ft
Dry service condition, untreated lumber, double span pattern
Deflection limitations: L/240 based on live load, L/180 based on total load

Deflection criteria check

Design live (snow) load w_L = 30 psf
Design total load w = 40 + 30 = 70 psf (80 + 30 = 110 psf to account for creep effects)

Using the appropriate deflection adjustments:
w_Δ = (360/240) x 59.5 = 89.2 psf > 30 psf for L/240 deflection (live load) √ Table w_Δ, L/360, double span
w_Δ = (240/180) x 89.2 = 118 psf > 110 psf for L/180 deflection (total load) √ Table w_Δ, L/240, double span

Use E1 105-3s, 4-1/8-inch thick slab.

Note: A complete design shall include the verification of bending and bearing capacities. Where slabs are used to support roof loads, the allowable spans for slabs may be limited by the IBC concentrated live load requirements (refer to article 1607.4 of the 2012 IBC).

EXAMPLE: **FLOOR SLAB**

Floor slab

Given a slab of 6-7/8 in. (175-5s); self weight = 18.3 psf ~ 20 psf
Design dead load = 50 psf (including slab self weight)
Design dead load (for creep effects) = 2.0 x 50 = 100 psf
Design live load = 40 psf
Beam spacing (span) = 17.5 ft
Dry service condition, untreated lumber, simple span pattern
Deflection limits: L/240 based on total load, L/360 based on live load, standard vibration criteria

Serviceability criteria check

Design dead load excluding slab self weight w_D = 30 psf
Design live load w_L = 40 psf
Design total load w = 50 + 40 = 90 psf (100 + 40 = 140 psf to account for creep effects)

w_Δ = 110 psf > 40 psf for L/360 deflection (live load) √ Table w_Δ, L/360, simple span
w_Δ = 165 psf > 140 psf for L/240 deflection (total load) √ Table w_Δ, L/240, simple span
ℓ_{max} = 19'-4" > 17'-6" for simple span (ratio 1:1) √ Table ℓ_{max}, 30 psf, standard cr.

Use E1 175-5s, 6-7/8-inch thick slab.

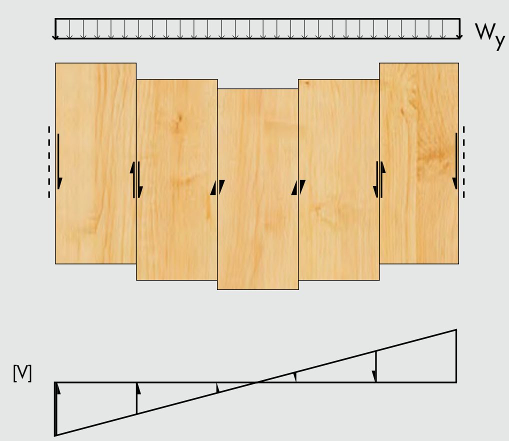
Note: A complete design shall include among other things the verification of a concentrated live load (if applicable), bending and bearing capacities, and fire safety requirements.

DIAPHRAGMS

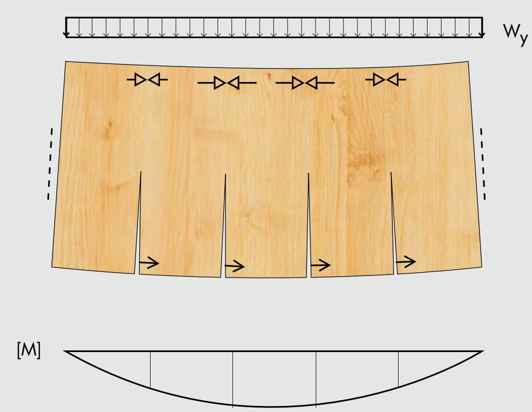
Sufficiently rigid diaphragms are paramount for the overall building rigidity. Diaphragms are created by joining the adjacent slab segments to each other along their edges using metal fasteners, such as screws. A continuous floor/roof diaphragm is necessary to correctly distribute lateral loads to supporting walls and stories below. Openings in diaphragms are generally not critical and only require simple constructive measures.

The relevant possible failure mechanisms of a cross-laminated timber diaphragm and diaphragm segments are shown in the figures below. Lateral loads create shear forces along the slab joints (left figure), and to compression and tension forces at the slab segment chords (right figure). Detail 1i shows the floor-to-floor or roof-to-roof connection, which resists shear forces along the slab segment joints. The tension force within the segment chords can be carried to the walls below by the floor/roof-to-wall connections (see details 1g, 1j, and 1k), if continuous walls are present. If the floor/roof-to-wall connections are not sufficient to resist the tension force (e.g. in walls with frequent or large openings), the floor-to-floor or roof-to-roof shear connections must be designed to resist the tensional forces in addition to the shear forces.

DIAPHRAGM – SHEAR FORCES ALONG SLAB JOINTS



DIAPHRAGM – TENSION FORCES AT SEGMENT CHORDS



DESIGN PROPERTIES
WALLS

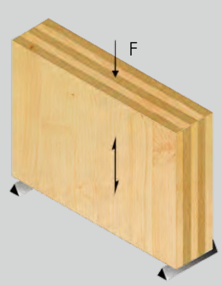
DESIGN PROPERTIES – walls and lintels

APPLICATION	WALLS AND LINTELS						
APPEARANCE GRADES	INDUSTRIAL OR ARCHITECTURAL						
STRESS GRADE	E1 (L 1950F_b and T No. 3/Stud)						
LAYUP COMBINATIONS	78-3s	105-3s	131-5s	175-5s	220-7s	244-7l	314-9l
Loaded to major strength axis							
Compression, P_0 (10^3 lbf/ft)	44	59	66	89	119	149	178
Tension, T_0 (10^3 lbf/ft)	34	45	50	68	91	113	136
Effective area, A_{eff} (in.^{2}/ft)	24	33	37	50	66	83	99
Effective inertia, I_{eff} (in.^{4}/ft)	28	68	108	257	498	824	1638
Radius of gyration, r_{eff} (in./ft)	1.1	1.4	1.7	2.3	2.7	3.2	4.1
In-plane shear, V_0 (lbf/in.)	304	396	597	792	912	1188	1584
Loaded to minor strength axis							
Compression, P_{90} (10^3 lbf/ft)	8.2	11	16	21	25	21	32
Tension, T_{90} (10^3 lbf/ft)	3.2	4.1	6.3	8.3	9.5	8.3	12
Effective area, A_{eff} (in.^{2}/ft)	13	17	25	33	38	33	50
Effective inertia, I_{eff} (in.^{4}/ft)	1.2	2.6	30	68	153	68	257
Radius of gyration, r_{eff} (in./ft)	0.3	0.4	1.1	1.4	2.0	1.4	2.3
In-plane shear, V_{90} (lbf/in.)	304	396	597	792	912	1188	1584

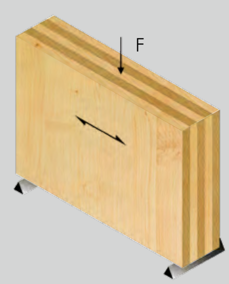
(1) The tabulated design values are for dry conditions of use and normal duration of loading.
(2) Nordic X-Lam bending panels are symmetrical throughout the thickness of the member (balanced layups).
(3) The compression parallel to grain capacity values, P, shall be adjusted by the column stability factor, C_p, as defined in NDS-2012.
(4) The compression perpendicular to grain values shall be based on S-P-F No. 3 lumber (f_{cp} = 425 psi).
(5) The bending moment capacity and stiffness shall be based on S-P-F No. 3 (f_b = 500 psi, E = 1,200,000 psi) or S-P-F MSR 1950f (f_b = 1950 psi, E = 1,700,000 psi) lumber for vertical or horizontal panel, respectively, and an effective cross-section based on the layers perpendicular to the load.
(6) The in-plane shear capacities, V_r, are given in lbf/in. of member height. These values are based on the TUGraz study with the specified strengths $f_{v,clt,k}$ = 5.0 MPa and $f_{v,clt,k}$ = 2.5 MPa, adjusted with the following factors: k_{mod} = 0.8, γ_M = 1.25. *(Ref. BSPhandbuch, TUGraz)*
(7) The design of cross-laminated timber members shall be in accordance to NDS-2012 and the CLT Handbook, U.S. Edition.
(8) The specific gravity for dowel-type fastener design is 0.41. Member weight shall be based on density of 32 pcf.

** Nordic X-Lam products are certified by APA (Product Report PR-L306), per the ANSI/APA PRG 320 Standard.*

LOADING ABOUT THE MAJOR STRENGTH AXIS



LOADING ABOUT THE MINOR STRENGTH AXIS



For the ANSI/APA PRG 320 Standard:
http://www.apawood.org/pdfs/download_pdf.cfm?PDFFilename=managed/PRG_320-2012.pdf

For the APA Product Report:
http://nordic.ca/en/documentation/technical-documents/apa-pr-l306

To verify that the tabulated maximum axial uniform loads are appropriate for the structure being designed, the following questions should be asked (the appropriate modification factor is given in brackets):

1. **Is load duration "normal" (C_D)?**
   C_D is a load duration factor. The tabulated maximum axial uniform loads are based on a normal duration of loading (CD = 1.0), which includes the effects of dead loads plus live loads due to use and occupancy, and snow loads.

2. **Is the service condition "dry" (C_M)?**
   C_M is a wet service factor. The tables are limited to dry service conditions (C_M = 1.0).

3. **Is the effective length factor, K_e, equal to 1.0 and the effective panel length in the direction of buckling equal to the total panel length?**

4. **Is the wall concentrically loaded or subjected to a maximum eccentricity of 1/6 the panel tickness?**

If the answer to any of these questions is no, the Wall Selection Tables may not be used. Instead, calculate P_r from the formula given in NDS-2012. Information on eccentrically loaded walls is provided in the CLT Handbook, U.S. Edition.

Note that in certain cases the International Building Code permits a reduction in uniform live loads depending upon the size of the tributary area (refer to Article 1607.10 of the 2012 IBC).

Note: Since wall design is an iterative process, the tables may be used to select a trial section. When designing a panel with an effective length factor K_e other than 1.0, a preliminary section may be selected by using the table for K_e = 1.0 with L equal to the actual effective length K_eL. The preliminary section can then be checked using the design standard (note the difference between the estimated resistance and the actual resistance will not usually exceed 5%).

Earthquake safety of buildings
Buildings are constructed with panels of a maximum width of 2440 mm. The panels are joined together by mechanical fasteners. The connection between the panels, which make up the walls and ceilings, is done through metal plates, ring shank nails and self-tapping screws. Usage of plates with limited sizes makes handling and installation easy and, owing to the integration of a great number of mechanical connections, enhances ductility as well as the building's capacity to dissipate energy generated by the earthquake.

WALLS
E1 SELECTION TABLES

ECCENTRICITY OF 1/6
ALLOWABLE UNIFORM LOAD P (lbf)

L (ft)	MAJOR STRENGTH AXIS				MINOR STRENGTH AXIS	
	LAYUP COMBINAISON				LAYUP COMBINAISON	
	78-3s	105-3s	131-5s	175-5s	131-5s	175-5s
6	18,450	30,390	36,750	53,310	6,530	9,330
7	15,850	27,640	34,500	51,530	6,080	8,940
8	13,600	24,840	32,020	49,500	5,590	8,520
9	11,700	22,180	29,420	47,240	5,090	8,070
10	10,130	19,750	26,820	44,790	4,610	7,590
12		15,730	22,080	39,540		6,610
14		12,680	18,200	34,340		5,660
16			15,110	29,640		
18				25,600		
20				22,190		
22				19,340		
24				16,950		
26				14,930		
28				13,210		
30						

CONCENTRIC END LOADS
ALLOWABLE UNIFORM LOAD P (lbf)

L (ft)	MAJOR STRENGTH AXIS				MINOR STRENGTH AXIS	
	LAYUP COMBINAISON				LAYUP COMBINAISON	
	78-3s	105-3s	131-5s	175-5s	131-5s	175-5s
6	29,730	49,150	59,300	83,490	15,030	20,470
7	24,930	44,990	56,780	82,020	14,230	20,070
8	20,720	40,130	53,370	80,090	13,100	19,520
9	17,270	35,200	49,140	77,600	11,690	18,780
10	14,510	30,640	44,420	74,440	10,190	17,790
12		23,260	35,250	66,170		15,150
14		17,960	27,810	56,520		12,270
16			22,190	47,360		
18			17,980	39,590		
20			14,790	33,270		
22				28,180		
24				24,080		
26				20,740		
28				18,010		
30						

NOTES:

1. The tabulated axial loads are based on simply axially loaded walls subjected to a maximum eccentricity of 1/6 wall thickness, or on simply axially loaded walls subjected to concentric end loads only. For side loads, other eccentric end loads, or other combined axial and flexural loads, see the CLT Handbook, U.S. Edition.
2. Values shown are the allowable uniform loads, in kN/m, that can be applied to the wall in addition to its own weight.
3. For L ≤ 6 ft, use P for L = 6 ft. Where P values are not given, the slenderness ratio exceeds 150 (maximum permitted).
4. A complete design shall include the verifications of bearing capacity and fire safety requirements.
5. L = unsupported length

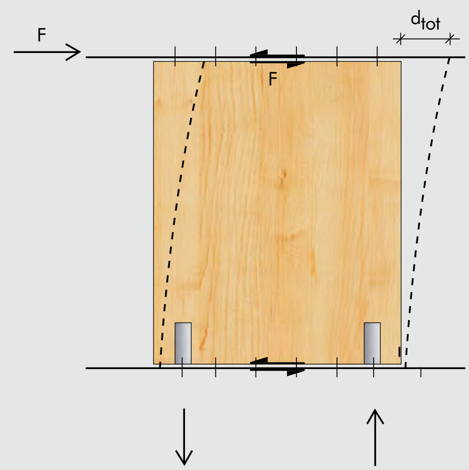
The lateral deflection, or storey drift, shall be limited to h/300, where h is the storey height. It is however strongly recommended to limit storey drift to h/500. As shown in the figure below, the total lateral deflection is a result of wall panel bending and shear deformation, and tensile and shear deformation of metal connectors. Due to the relatively high rigidity of the cross-laminated timber panels, the deformation of the metal connectors is typically the dominating factor.

Flexural deformation of wall panel	d_{mp}
Shear deformation of wall panel	d_{vp}
Elongation of metal connectors due to tensile force	d_{tc}
Shear deformation of metal connectors	d_{vc}

The total lateral deflection is calculated as follows:

$$d_{tot} = d_{mp} + d_{vp} + d_{tc} + d_{vc}$$

LATERAL DEFLECTION OF WALL PANEL



TECHNICAL DATA

Construction	Multi layered; 3, 5, 7, and 9 plies « E1 » stress grade
Dimensions	- Maximum width of 8 feet; including lapped-joints of 2-1/2 inches (64 mm) - Lengths up to 64 feet (19.5 meters) - Thicknesses from 3 to 15 in. (78 to 381 mm); standard 3-1/8 (78), 4-1/8 (105), 5-1/8 (131), 6-7/8 (175), 8-5/8 (220), 9-5/8 (244), and 12-3/8 in. (314 mm)
Joint profile	2-1/2-inch (64 mm) width lapped joint, on both sides
Appearance grade	Industrial (architectural upon request)
Certification	APA Product Report PR-L306; FSC certified products available
Lumber species	Spruce-Pine-Fir (S-P-F)
Lamellas	Longitudinal lamellas 1950f MSR, transversal No. 3
Adhesives	Weatherproof adhesives, formaldehyde free; low volatile organic compounds (VOC) limits
Density	± 32 pcf, Spruce-Pine-Fir
Moisture content	12 ± 2 %
Dimensional changes	- Longitudinal and transversal: 0.01% per % change in moisture content - Panel thickness: 0.20% per % change in moisture content
Thermal resistance	R = 5 ft^2 h °F/BTU per 4 inches
Acoustic resistance	Wood as a material has good sound attenuation properties; sound transmission (STC) and impact insulation (IIC) classes for typical assemblies are shown in the following pages - more information available upon request.
Fire safety	- The fire separating function of CLT panel assemblies can easily be met provided that the panels and joints between panels are effectively sealed to prevent air or hot gases from penetrating the assembly during fire exposure. - Nominal charring rate of 1.5 in./hr; see fire-resistance ratings (FRR) for typical assemblies - The flame spread and smoke developed indexes are within the limits of Class B, as defined in Section 803.1 of the IBC (tests report available upon request)
Environmental performance	- Available readily manufactured from wood certified as harvested from sustainably managed forests - Long-term storage of the carbon absorbed by the sustainably grown trees - Production of CLT resulting in far less greenhouse gas emissions than many non-wood materials - Equivalent or better characteristics than functionally equivalent concrete and steel systems in other aspects of environmental performance such as thermal performance

ADVANTAGES

Flexible design	Unrestricted designing without being bound to a grid
Simple component	Simple building component construction and detailed planning
Detailed planning	Minimum designing risk due to detailed planning documents
Advanced possibilities	Advanced possibilities due to an efficient building material
Identical compositions	Identical construction for all applications (wall/floor/roof)
Solid construction	Mass timber building components, no extra bracing required
Short erection period	Short construction period on site, economic assembly
Ready-to-install products	Ready-to-install joined building components, delivered on time
Simple connection details	Simple connection details, easy to execute
Durability	Durable, solid and high quality timber construction
Sustainable material	Ecological, carbon storing material (1 m^3 of wood = 1 ton of encapsulated CO_2)
Warmth	Pleasant, warm in-door climate

PHYSICAL
PROPERTIES

The use of cross-laminated timber panels does not change the basic heat, air and moisture control design criteria. However, different from conventional stick-built wood-frame buildings, the design of cross-laminated timber building enclosures requires additional attention due to the unique characteristics of the product. The overlying strategies are to place insulation in such a way that the panels are kept warm and dry, to prevent moisture from being trapped or accumulating within the panel, and to control airflow through the panels, and at the joints and interfaces between them.

HEAT CONTROL

Cross-laminated timber panels have an R value of approximately 1.2 ft^2 h °F/BTU per inch, and when used with sufficient insulation can meet the requirements of applicable energy codes. Most types of insulation should be used on the exterior side of the panel in order to keep the wood warm and dry. Panels can then be left exposed in the building's interior to showcase the natural beauty of wood, if doing so is permitted by fire safety and acoustics requirements.

THERMAL PROPERTIES	
Thermal resistance (R)	1.2 h-ft²-°F/Btu-inch
Heat conductivity (λ)	0.12 W/m•K
Density (ρ)	32 pcf

VAPOR DIFFUSION CONTROL

The goal of vapor diffusion control is to prevent condensation from forming within the walls of a structure by limiting the movement of moisture through building materials by vapor diffusion. In traditional wood-frame walls, vapor diffusion is controlled by installing a vapor barrier within the wall, which prevents warm, humid air from passing through.

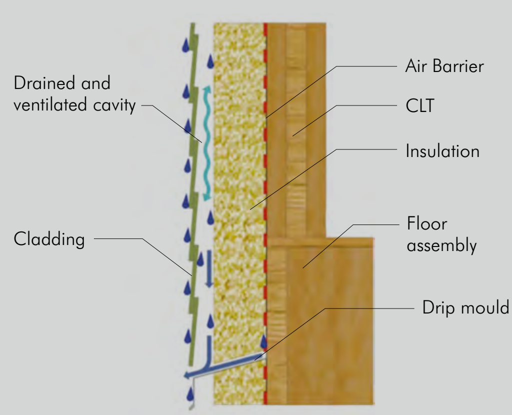
However, the low vapor permeability of cross-laminated timber (less than 0.5 US perms for a 3-1/2-in.-thick panel) ensures that in most situations, moisture flow is controlled by the timber itself. Because the materials on the structure's exterior must be sufficiently vapor permeable so as not to trap moisture, we recommend using wood- or mineral-fiber insulation boards rather than polystyrene products.

WATER PENETRATION CONTROL

The best way to prevent rainwater from penetrating a wall is to install cladding and a drained and ventilated rainscreen. While the cladding will provide adequate protection from most of the rainwater that falls on the structure, water that does enter the wall will drip down the rainscreen, the strapping, the surface of the insulation or the inside of the cladding. Drip moulds must be installed around openings and at floor-wall intersections in order to divert moisture.

MOISTURE PROTECTION PROPERTIES	
Vapor diffusion resistance factor (μ)	~ 60
Diffusion equivalent air layer thickness (s_d)	μ x t (in m)
Vapor permeability (r)	< 0.5 US perms

CROSS SECTION OF WALL

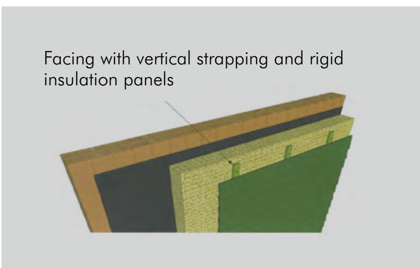


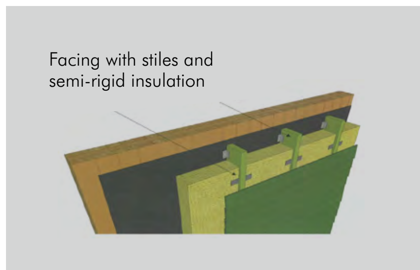
AIR LEAKAGE CONTROL

Although cross-laminated timber panels are mass timber components, they cannot provide adequate protection against air leakage on their own. We recommend installing another material, such as a rainscreen, between the panel and the insulation in order to create an effective air barrier system. As in traditional light framework construction, proper detailing to maintain air barrier continuity at openings and interfaces is essential.

EXTERIOR WALL DETAILS

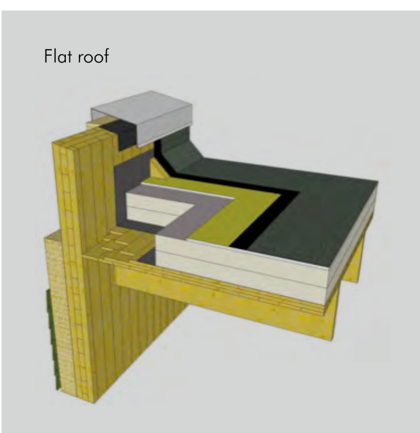
Installing insulation boards on cross-laminated timber panels using vertical strapping is recommended in order to facilitate the installation of cladding and create necessary drainage space. If less rigid insulation boards, such as glass fiber or mineral wool boards, are used, framing members must be installed in order to support the cladding. However, this option increases thermal bridging.





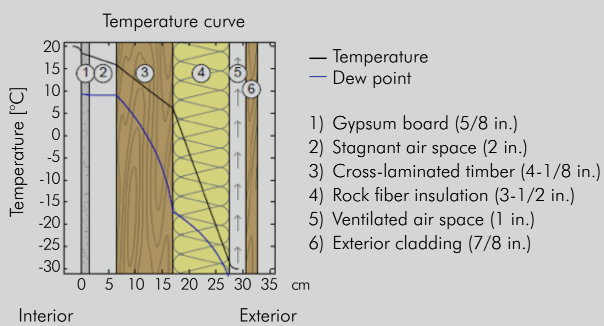
ROOF DETAILS

The same design considerations for cross-laminated timber wall panels also apply to pitched roofs. In the case of flat or low-slope roofs, it is preferable to use a traditional roof assembly in order to ensure that the panels are adequately protected. As with traditional roof top terrace using light-framing with plywood sheathing, the air barrier, insulation and roofing membrane are installed on top of the panel.



HYGROTHERMAL PERFORMANCE

Built structures seek to establish an equilibrium between indoor and outdoor climate conditions. The impact of seasonal conditions depends upon the climate of the building's location (latitude and longitude). Detailed analysis must be carried out prior to the final planning stage in order to determine how a building component will react to climate conditions and interact with the rest of the structure.



FIRE PERFORMANCE

Fire protection requirements (e.g. 1- or 2-hr fire resistance) can be met by employing a calculation method based on the char rate of unprotected panels subjected to standard fire exposure. Fire resistance can be improved further by installing gypsum board on the exposed side of cross-laminated timber panels.

In a large-scale fire performance test conducted by IVALSA on a three-story cross-laminated timber building, panels with gypsum board were found to have better resistance against the combustion of the contents of a room and to restrict the spread of fire to other floors or rooms. The fact that cross-laminated timber buildings generally contain fewer concealed spaces than traditional structures also reduces the risk of fire spread.

FIRE PERFORMANCE PROPERTIES	
Char rate	1.5 in./hour
Flame Spread Classification	35
Smoked Developed Classification	40

GYPSUM BOARD PROTECTION	
One layer of 1/2 in. type X gypsum board	15 min
One layer of 5/8 in. type X gypsum board	30 min
Two layers of 5/8 in. type X gypsum board	60 min

ACOUSTIC PERFORMANCE

Solid wood panels can provide very satisfactory acoustic performance when used in walls and ceilings. The structures on the next few pages have all been tested for acoustic performance; details for other wall and floor options are available upon request. Sound control details should always be specified at the beginning of the design and construction phase in order to minimize indirect noise transfer.

ENERGY EFFICIENCY AND COMFORT

Cross-laminated timber buildings go beyond insulation requirements, providing increased energy efficiency and an improved indoor climate. Cross-laminated timber absorbs and releases large amounts of moisture, transferring a portion of it outside the building. Much like log homes, cross-laminated timber structures “breathe”, thereby stabilizing indoor humidity levels and reducing ventilation energy load.

Cross-laminated timber panels also boast a higher thermal mass than light framework, resulting in cooler indoor temperatures in summer and increased heat retention in winter. Using cross-laminated timber can therefore lead to lower annual heating and air conditioning costs. What’s more, wood left exposed in a building’s interior becomes a “hot surface” that radiates heat throughout a room. This radiant heat helps regulate indoor temperatures, making spaces more comfortable for their users.

CARBON FOOTPRINT

A material’s carbon footprint measures the level of carbon dioxide (CO_2) emitted in its production. CO_2 emissions are the largest cause of global warming and the greenhouse effect.

Not only do timber products have a reduced carbon footprint due to their production process, they also sequester carbon over the entire lifetime of a built structure. What’s more, sustainably managed forests act as carbon sinks. Replacing other building materials with timber therefore reduces the construction industry’s impact on the climate.

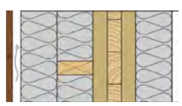
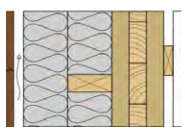
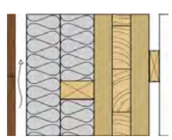
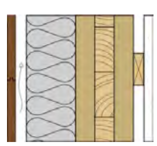
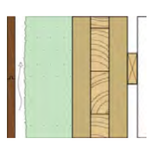
CARBON FOOTPRINT (per m^3)	
Carbon absorbed in forests	765 kg CO_2eq.

DURABILITY

The short erection time of cross-laminated timber systems generally limits weather exposure. Short-term, occasional exposure to water does not have lasting effects on the panels. Long-term exposure to the elements is not recommended. When built according to best practices, timber structures are remarkably long lasting. Japan’s Hōryō-ji Buddhist temple (607) and Switzerland’s Kapellbrücke bridge (1333), both still in use today, proudly showcase the exceptional durability of wood.

TYPICAL
COMPOSITIONS
EXT. WALLS

TYPICAL COMPOSITIONS — EXTERIOR WALLS

EXTERIOR WALL TYPE	No	DESCRIPTION[1]	FRR[2]	RSI[3]	R[4]
	**E1.1**	- wood furring, 2 rows of 3-1/2 in. at 24 in. o.c. - rock fiber insulation, 2 layers of 3-1/2 in. - cross-laminated timber 4-1/8 in. - wood furring, 3-1/2 in. at 24 in. o.c. - rock fiber insulation, 3-1/2 in. - 1 layer 5/8 in. Type X gypsum board	1 h	8.0	45
	**E2**	- wood furring, 2 rows of 3-1/2 in. at 24 in. o.c. - rock fiber insulation, 2 layers of 3-1/2 in. - cross-laminated timber 4-1/8 in.	n/a	5.6	32
	E2.1	- wood furring, 2 rows of 3-1/2 in. at 24 in. o.c. - rock fiber insulation, 2 layers of 3-1/2 in. - cross-laminated timber 4-1/8 in. - wood furring, 3/4 in. at 24 in. o.c. - 1 layer 5/8 in. Type X gypsum board	1 h	5.7	32
	**E3**	- wood furring, 2 rows of 2-1/2 in. at 24 in. o.c. - rock fiber insulation, 2 layers of 2-1/2 in. - cross-laminated timber 4-1/8 in.	n/a	4.3	24
	E3.1	- wood furring, 2 rows of 2-1/2 in. at 24 in. o.c. - rock fiber insulation, 2 layers of 2-1/2 in. - cross-laminated timber 4-1/8 in. - wood furring, 3/4 in. at 24 in. o.c. - 1 layer 5/8 in. Type X gypsum board	1 h	4.4	25
	**E4**	- wood furring, 3-1/2 in. at 24 in. o.c. - rock fiber insulation, 3-1/2 in. - cross-laminated timber 4-1/8 in.	n/a	3.3	19
	E4.1	- wood furring, 3-1/2 in. at 24 in. o.c. - rock fiber insulation, 3-1/2 in. - cross-laminated timber 4-1/8 in. - wood furring, 3/4 in. at 24 in. o.c. - 1 layer 5/8 in. Type X gypsum board	1 h	3.4	19
	**E5**	- wood furring, 3-1/2 in. at 24 in. o.c. - sprayed foam insulation, 3-1/2 in. - cross-laminated timber 4-1/8 in.	n/a	4.4	25
	E5.1	- wood furring, 3-1/2 in. at 24 in. o.c. - sprayed foam insulation, 3-1/2 in. - cross-laminated timber 4-1/8 in. - wood furring, 3/4 in. at 24 in. o.c. - 1 layer 5/8 in. Type X gypsum board	1 h	4.5	26

NOTES:

(1) The designer shall include at least the siding, air space and air barrier in the above compositions.

(2) Fire resistance rating determined by testing according to CAN/ULC S101, *Standard methods of fire endurance tests of building construction and materials,* with restricted load use conditions and/or based on the char rate design methodology (CAN/ULC S101 reproduces the standard fire severity of the ASTM E119 standard). Higher fire resistance ratings may be possible by design.

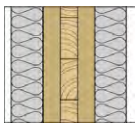
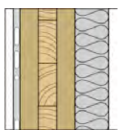
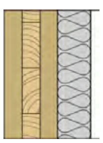
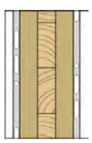
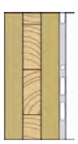
(3) Total thermal resistance of the wall element (m^2 °C/W); to convert the RSI value to R value, divide the RSI value by 0.1761.

(4) Total thermal resistance of the wall element (R value); see minimum requirements according to the 2012 IECC on page 31.

(5) Good thermal insulation is never arbitrary and must always be chosen according to location, zone, and climate.

INT. WALLS

TYPICAL COMPOSITIONS — INTERIOR WALLS

INTERIOR WALL TYPE	No	DESCRIPTION	FRR[1]	STC[2]
	M1	- 1 layer Type X gypsum board - mineral wool, 2-1/2 in. - wood studs, 2-1/2 in. at 24 in. o.c. - cross-laminated timber 4-1/8 in. - wood studs, 2-1/2 in. at 24 in. o.c. - mineral wool, 2-1/2 in. - 1 layer 5/8 in. Type X gypsum board	1 h	58[3]
	M2	- 1 layer Type X gypsum board - resilient metal channels at 16 in. o.c. - cross-laminated timber 4-1/8 in. - air gap, 1/2 in. (optional) - wood studs, 2-1/2 in. at 24 in. o.c. - mineral wool, 2-1/2 in. - 1 layer 5/8 in. Type X gypsum board	1 h	53[4]
	M3	- cross-laminated timber 4-1/8 in.	30 min.	33[3]
	M3.1	- cross-laminated timber 4-1/8 in. - air gap, 1/2 in. (optional) - wood studs, 2-1/2 in. at 24 in. o.c. - mineral wool, 2-1/2 in. - 1 layer 5/8 in. Type X gypsum board	30 min.	50[4]
	M4	- 1 layer Type X gypsum board - resilient metal channels at 16 in. o.c. - cross-laminated timber 4-1/8 in. - resilient metal channels at 16 in. o.c. - 1 layer Type X gypsum board	1 h	37[3]
	M5	- cross-laminated timber 4-1/8 in.	30 min.	33[3]
	M5.1	- cross-laminated timber 4-1/8 in. - resilient metal channels at 16 in. o.c. - 1 layer Type X gypsum board	30 min.	n/d

NOTES:

(1) Fire resistance rating determined by testing according to CAN/ULC S101, *Standard methods of fire endurance tests of building construction and materials,* with restricted load use conditions and/or based on the char rate design methodology (CAN/ULC S101 reproduces the standard fire severity of the ASTM E119 standard). Higher fire resistance ratings may be possible by design.

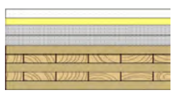
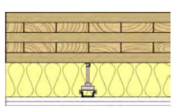
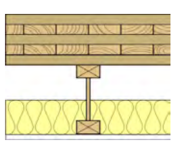
(2) Walls and partitions assemblies separating dwelling units from each other or from public or service areas shall have a sound transmission class (STC) of not less than 50 (45 if field tested) for air-borne noise when tested in accordance with ASTM E 90. *(Ref. 2012 IBC, Article 1207.2)*

(3) Value based on a 4-1/8 in. wood panel. *(Ref. CLT Hanbook, Chapter 9)*

(4) Value obtained from field test results, adjusted for STC. *(Ref. Reseach report, FPInnovations, 2014)*

FLOORS

TYPICAL COMPOSITIONS — FLOORS

FLOOR TYPE	No	DESCRIPTION	FRR[1]	STC[2]	IIC[3]
	**P1**	- gypsum fiberboard FERMACELL, 1 in. - sub-floor ISOVER EP3, 0.79 in. - honeycomb acoustic infill (screed), 2x 1.18 in. - Kraft paper underlayment - cross-laminated timber 6-7/8 in.	1.5 h	62	59
	P1.1	+ 1 layer 5/8 in. Type X gypsum board	2 h	> 62	> 59
	**P2**	- carpet or floating flooring, about 2/5 in. - resilient underlayment (rubber mat or textured felt), 0.12 in. - at least 15.6 lb/ft^2 wet topping (concrete, gypcrete, gypsum) - resilient underlayment (2/5 in. rubber mat, 3/4 in. textured felt, or 1/2 in. low density wood fiberboard) - cross-laminated timber 6-7/8 in.	1.5 h	> 53[4]	> 55[4]
	P2.1	+ 1 layer 5/8 in. Type X gypsum board	2 h	> 53[4]	> 55[4]
	**P3**	- carpet or floating flooring, about 2/5 in. - resilient underlayment (rubber mat or textured felt), 0.12 in. - at least 25 kg/m^2 dry topping (20 mm Fermacell, cement fiberboard, or Fiberrock) - resilient underlayment (2/5 in. rubber mat, 3/4 in. textured felt, or 1/2 in. low density wood fiberboard) - cross-laminated timber 6-7/8 in.	1.5 h	> 48[4]	> 50[4]
	P3.1	+ 1 layer 5/8 in. Type X gypsum board	2 h	> 48[4]	> 50[4]
	**P4**	- cross-laminated timber 6-7/8 in.	1.5 h	39[5]	27[5]
	P4.1	- cross-laminated timber 6-7/8 in. - sound insulation clips of 4 in. high - metal hat channels, at min. 16 in. o.c. - sound insulation material, 4 in. - 2 layers 1/2 in. Type X gypsum board	2 h	64	59
	**P5**	- cross-laminated timber 6-7/8 in.	1.5 h	39[5]	27[5]
	P5.1	- FERMACELL 2E32 <u>or</u> Permabase and Sonopan - cross-laminated timber 6-7/8 in. - 7-7/8 in. wood I-joists, 24 in. o.c. - sound insulation material, 3-1/2 in. - 1 layer 5/8 in. Type X gypsum board	2 h	59	54

NOTES:

(1) Fire resistance rating determined by testing according to CAN/ULC S101, *Standard methods of fire endurance tests of building construction and materials,* with restricted load use conditions and/or based on the char rate design methodology (CAN/ULC S101 reproduces the standard fire severity of the ASTM E119 standard). Higher fire resistance ratings may be possible by design.

(2) Floor/ceiling assemblies separating dwelling units from each other or from public or service areas shall have a sound transmission class (STC) of not less than 50 (45 if field tested) for air-borne noise when tested in accordance with ASTM E 90. *(Ref. 2012 IBC, Article 1207.2)*

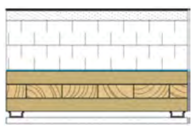
(3) Floor/ceiling assemblies between dwelling units or between a dwelling unit and a public or service area within the structure shall have an impact insulation class (IIC) rating of not less than 50 (45 if field tested) when tested in accordance with ASTM E 492. *(Ref. 2012 IBC, Article 1207.3)*

(4) Value obtained from field test results, adjusted for STC. *(Ref. Reseach report, FPInnovations, 2014)*

(5) Values have been adjusted for a 6-7/8 in. wood slab. *(Ref. CLT Hanbook, Chapter 9)*

ROOFS

TYPICAL COMPOSITIONS — ROOFS

ROOF TYPE	No	DESCRIPTION[1]	FRR[2]	RSI[3]	R[4]
	T1	- membrane and underlayment - fiberboard, 1 in. *(Perlite)* - rigid insulation, 4 in. - 2 ply vapor barrier - cross-laminated timber 4-1/8 in.	n/a	5.8	33
	T1.1	+ resilient metal channels at 16 in. o.c. + 1 layer 5/8 in. Type X gypsum board	1 h	5.9	33

NOTES:

(1) The designer shall include at least the siding, air space and air barrier to the above compositions.

(2) Fire resistance rating determined by testing according to CAN/ULC S101, *Standard methods of fire endurance tests of building construction and materials,* with restricted load use conditions and/or based on the char rate design methodology (CAN/ULC S101 reproduces the standard fire severity of the ASTM E119 standard). Higher fire resistance ratings may be possible by design.

(3) Total thermal resistance of the wall element (m^2 °C/W); to convert the RSI value to R value, divide the RSI value by 0.1761.

(4) Total thermal resistance of the wall element (R value); see minimum requirements according to the 2012 ICEE below.

(5) Good thermal insulation is never arbitrary and must always be chosen according to location, zone, and climate.

THERMAL ENVELOPE REQUIREMENTS

BUILDING TYPE	COMMERCIAL[3]		RESIDENTIAL	
BUILDING COMPONENT[1]	WALLS, ABOVE GRADE	ROOFS[4]	WOOD FRAME WALL	CEILING
CLIMATE ZONE[2]	R-VALUE	R-VALUE	R-VALUE[5]	R-VALUE
Zone 1, All other and Group R	R-13+3.8ci or R-20	R-20ci	13	30
Zone 2, All other and Group R	R-13+3.8ci or R-20	R-20ci	13	38
Zone 3, All other and Group R	R-13+3.8ci or R-20	R-20ci	20 or 13+5	38
Zone 4, All other and Group R	R-13+3.8ci or R-20	R-25ci	20 or 13+5	49
Zone 5, All other	R-13+3.8ci or R-20	R-25ci	n/a	n/a
Zone 5, Group R	R-13+7.5ci or R-20+3.8ci	R-25ci	20 or 13+5	49
Zone 6, All other and Group R	R-13+7.5ci or R-20+3.8ci	R-30ci	20+5 or 13+10	49
Zone 7, All other and Group R	R-13+7.5ci or R-20+3.8ci	R-35ci	20+5 or 13+10	49
Zone 8, All other and Group R	R-13+15.6ci or R-20+10ci	R-35ci	20+5 or 13+10	49

Where ci = Continuous insulation

NOTES:

(1) See appropriate references for other types of building components.

(2) The climate zones for a given location can be found in Chapter 3 of the 2012 International Energy Conservation Code.

(3) Commercial buildings or portions of commercial buildings enclosing Group R occupancies shall use the R-values from the "Group R" line of table above. Commercial buildings or portions of commercial buildings enclosing occupancies other than Group R shall use the R-values from the "All other" line of table above.

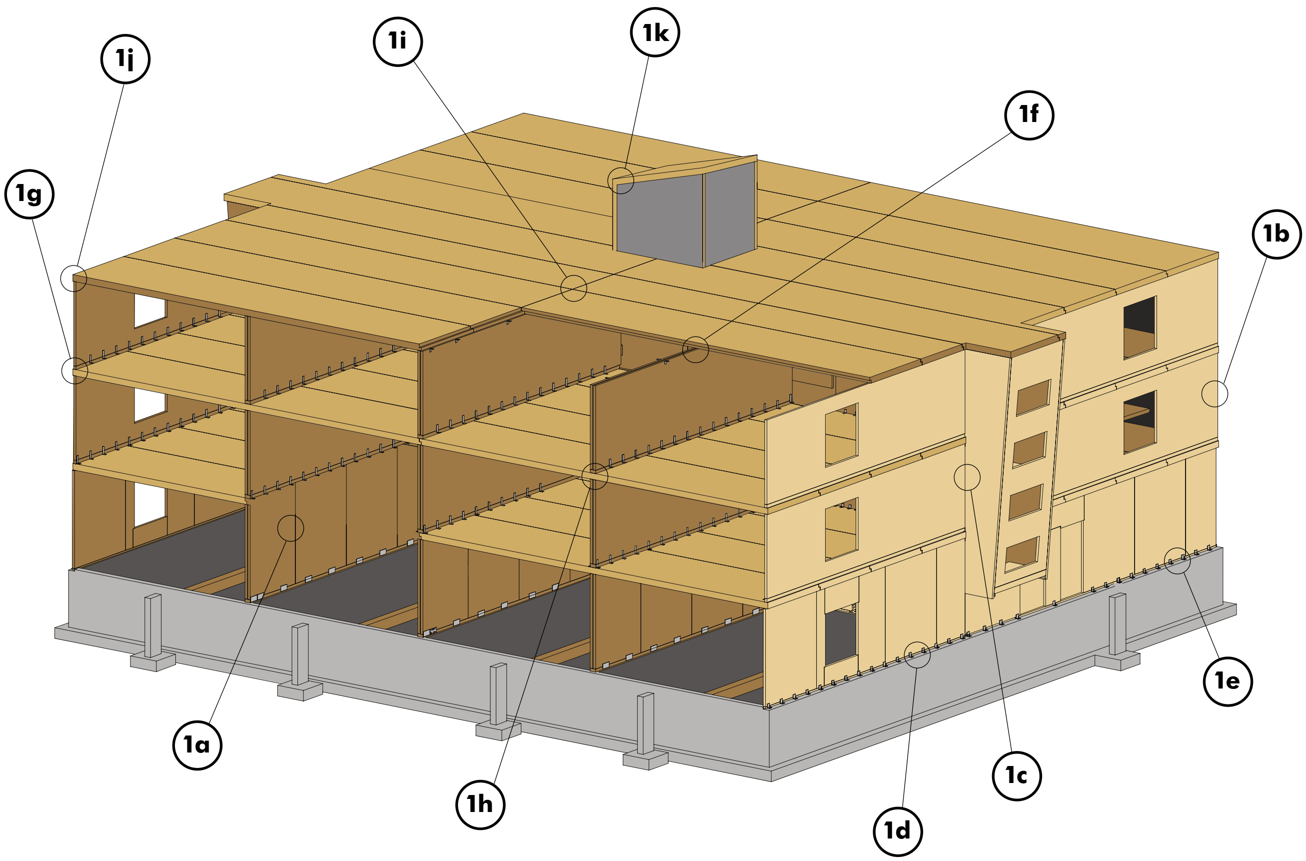
(4) Roofs insulation entirely above deck.

(5) First value is cavity insulation, second is continuous insulation or insulated siding, so "13+5" means R-13 cavity insulation plus R-5 continuous insulation or insulated siding. If structural sheathing covers 40 percent or less of the exterior, continuous insulation R-value shall be permitted to be reduced by no more than R-3 in the locations where structural sheathing is used – to maintain a consistent total sheathing thickness.

CONNECTION
DETAILS

FIGURE 1
TYPICAL CONNECTION DETAILS

These typical details are intended as guides; therefore quantities of connectors are illustrative only and drawings shall not be scaled. Some framing requirements such as erection bracing and blocking members have been omitted for clarity.



Proper connections details are important to the structural performance and serviceability of any timber-framed structure. Careful consideration of moisture-related expansion and contraction characteristics of wood is essential in detailing cross-laminated timber connections to prevent inducing tension perpendicular-to-grain stresses. It is also important to design connections to isolate all wood members from potential source of excessive moisture.

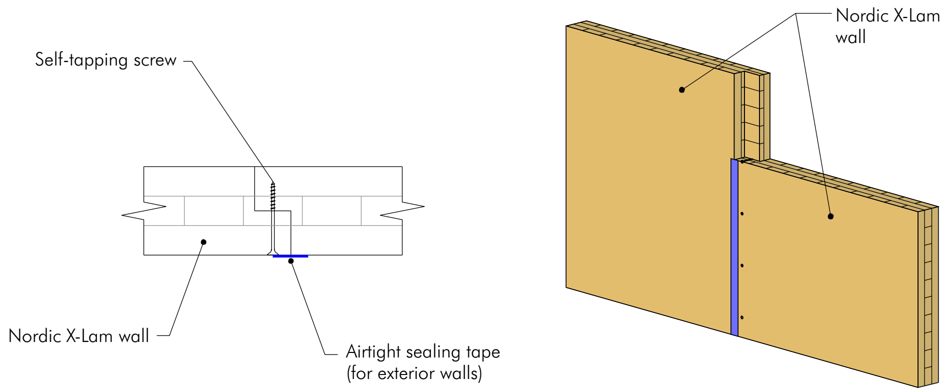
NOTES:

1. The details shown in Figure 1 are intended as guides. The final design shall include considerations for the capacities, end and edge distances, spacing between fasteners, dimensional changes, installation requirements, and fire safety - among other things.
2. Joint details should be avoided where shrinkage of the wood can lead to excessive tension perpendicular-to-grain stress.
3. Sufficient clearance must be provided between sides of steel connection hardware and wood members to permit installation.
4. Joints shall be assembled so that the surfaces are brought into close contact.
5. The design shall consider the required fire resistance rating, if applicable.

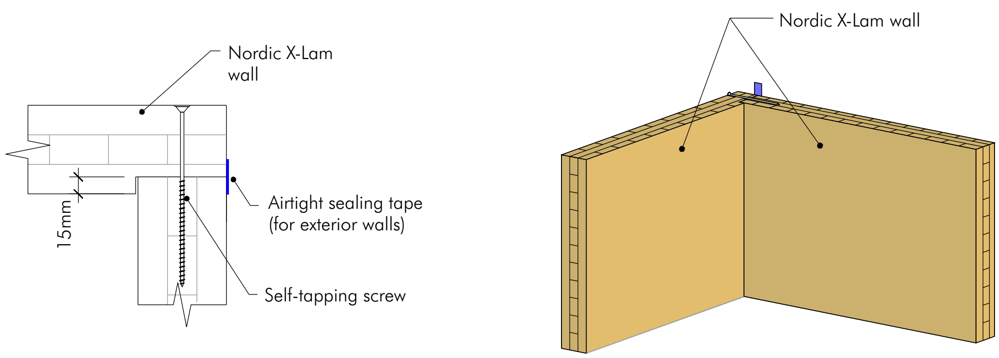
FIGURE 1

TYPICAL CONNECTION DETAILS (continued)

1a WALL JOINT



1b CORNER JOINT



1c CORNER JOINT

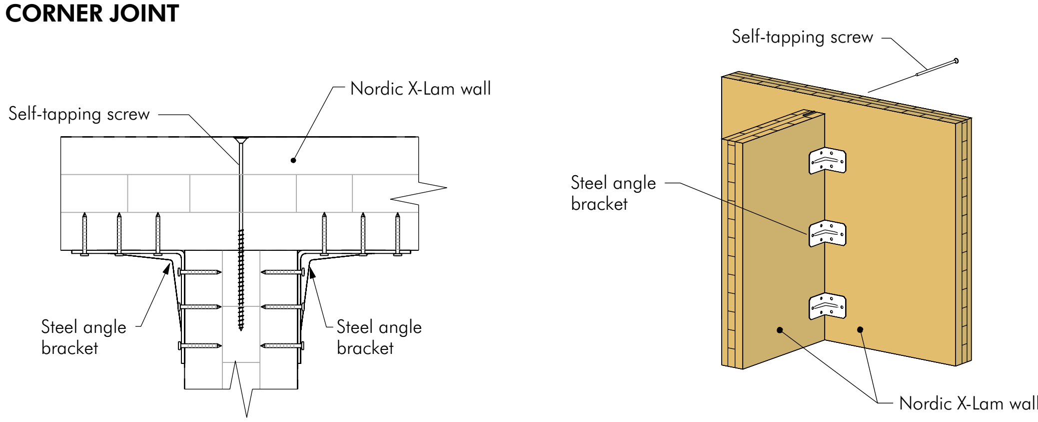
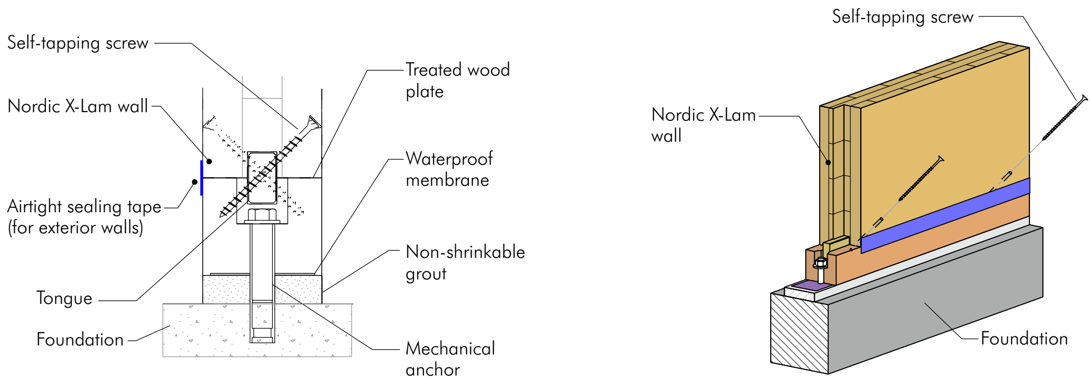
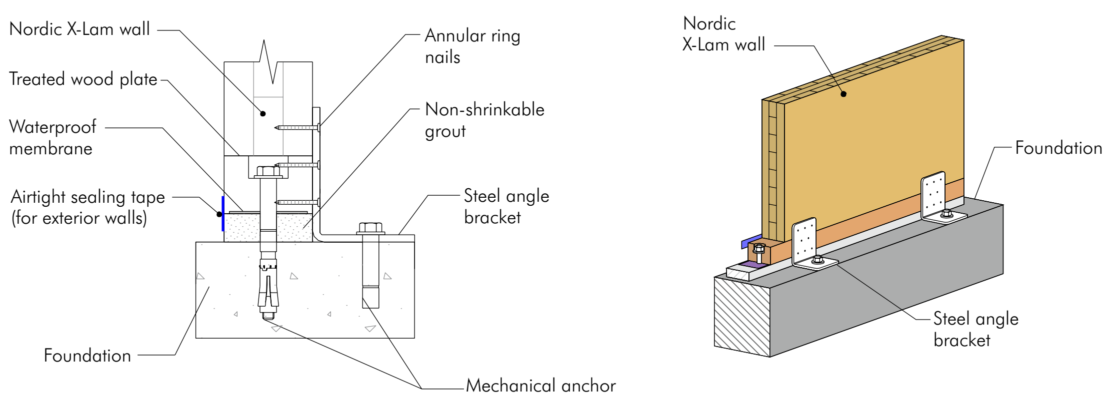


FIGURE 1
TYPICAL CONNECTION DETAILS (continued)

1d WALL/FOUNDATION DETAIL, WITH TONGUE & GROOVE



1e WALL/FOUNDATION DETAIL, WITH STEEL ANGLE BRACKETS



1f FLOOR/WALL CONNECTION

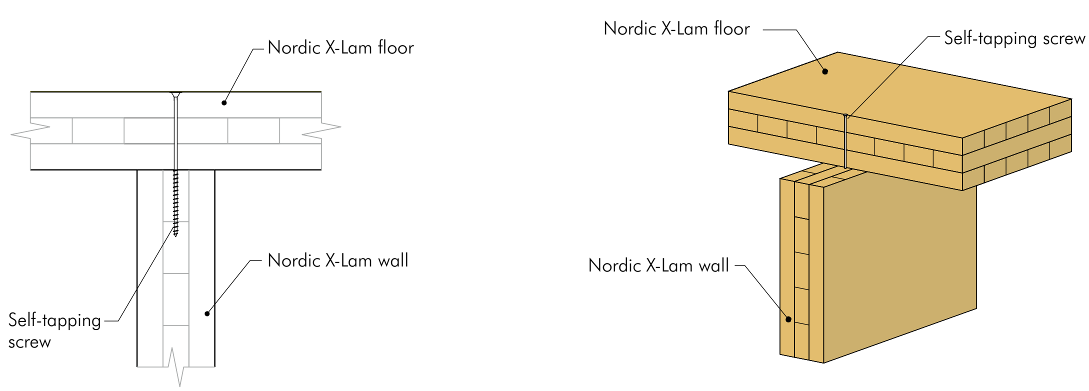
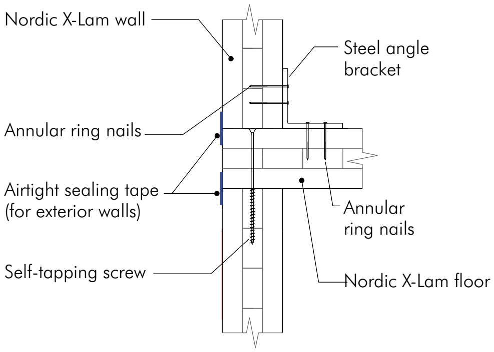
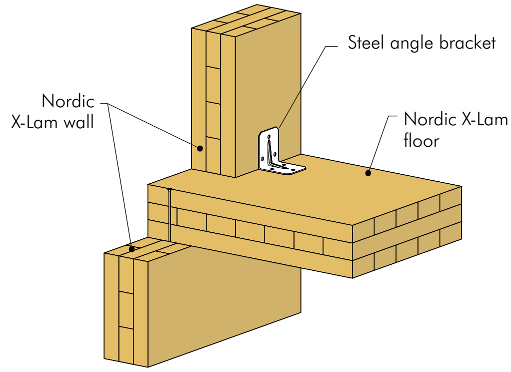


FIGURE 1
TYPICAL CONNECTION DETAILS (continued)

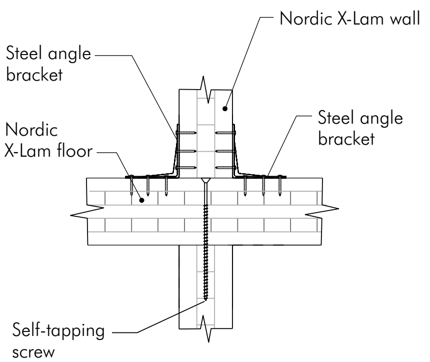
1g EXTERIOR WALL/FLOOR CONNECTION

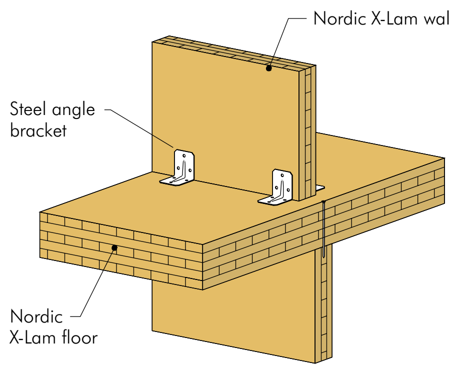




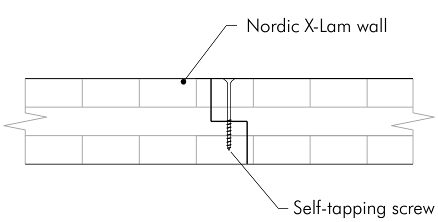
Note: Steel plates installed on the outside can be used instead of steel angle brackets.

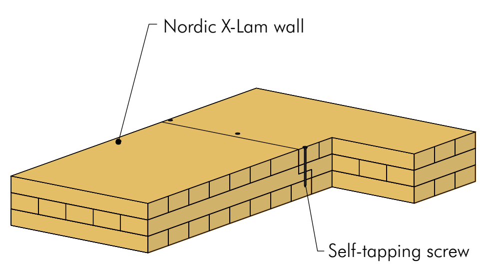
1h INTERIOR WALL/FLOOR CONNECTION





1i FLOOR (OR ROOF) JOINT

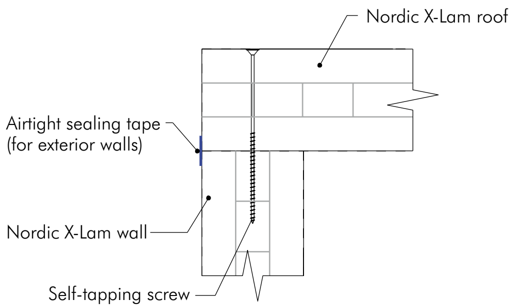


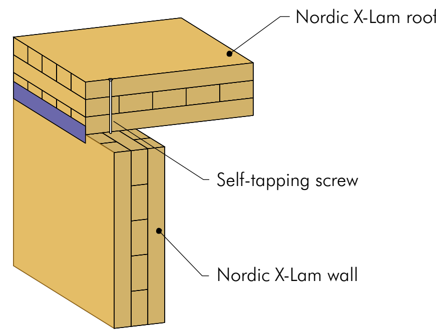


Note: A surface spline joint with plywood may be used instead of a half-lapped joint as shown.

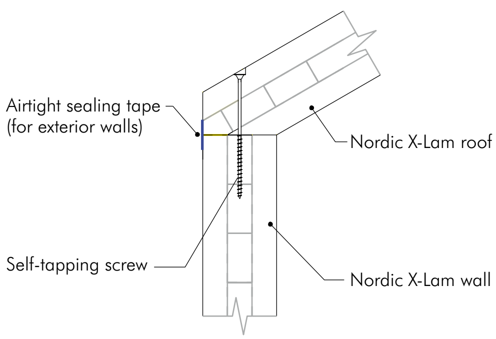
FIGURE 1
TYPICAL CONNECTION DETAILS (continued)

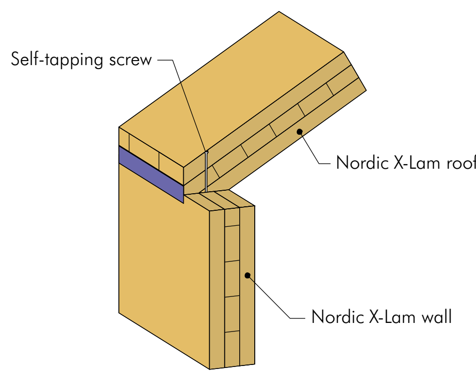
1j ROOF/WALL CONNECTION





1k SLOPED ROOF/WALL CONNECTION





While the details must address serviceability concerns associated with timber connection detailing, it is important to emphasize that all connection details must effectively transfer the design loads imposed on the structure and that all designs be in accordance with accepted engineering practice. The following basic principles, if followed, will lead to efficient, durable and structurally sound connections.

BASIC PRINCIPLES:

1. Transfer loads in compression bearing whenever possible.
2. Allow for dimensional changes in wood due to potential in-service moisture cycling.
3. Avoid the use of details that induce tension perpendicular-to-grain stresses in a member.
4. Avoid moisture entrapment at connections.
5. Do not place wood in direct contact with masonry or concrete.
6. Avoid eccentricity in joint details.
7. Minimize exposure of end grain.

A QUALIFIED DESIGNER SHOULD ALWAYS EVALUATE EACH ASSEMBLY , INCLUDING THE LIMITS OF WOOD MEMBERS.

FASTENERS
AND CONNECTORS

REFERENCE DESIGN VALUES, SCREWS (lbs)

PANEL THICKNESS (mm)	PANEL-TO-PANEL CONNECTIONS ASSY 3.0 Ø 6 mm[1]				SLAB-TO-WALL CONNECTIONS ASSY 3.0 Ø 8 mm[1]			
	DIAMETER (in. (mm))	LENGTH (in. (mm))	LATERAL[2] (lbs)	WITHDR.[3] (lbs)	DIAMETER (in. (mm))	LENGTH (in. (mm))	LATERAL[2] (lbs)	WITHDR.[3] (lbs)
78-3s	0.164 (4.2)	3 (76)	124	n/a	0.32 (8)	6.30 (160)	304	671
105-5s	0.24 (6)	3.94 (100)	277	n/a	0.32 (8)	7.87 (200)	304	671
131-5s	0.24 (6)	4.72 (120)	290	n/a	0.32 (8)	9.45 (240)	304	857
175-5s	0.24 (6)	6.30 (160)	290	n/a	0.32 (8)	11.02 (280)	304	857
208-7s	0.24 (6)	7.09 (180)	290	n/a	0.32 (8)	12.60 (320)	304	857
244-7sl	0.24 (6)	9.45 (240)	290	n/a	0.32 (8)	13.39 (340)	304	820
314-9sl	0.24 (6)	11.81 (300)	290	n/a	0.32 (8)	15.75 (400)	304	727

NOTES:
1. ASSY 3.0 self-tapping wood screws, for panel-to-panel half-lap joints (detail 1i) and slab-to-wall connections (detail 1j). For 78-3s panel-to-panel half-lap joints, wood screws number 8, 0.164 in. diameter x 3 in. length, per NDS-2015.
2. Reference lateral design value of one screw, based on a short-term duration of load (K_D = 1.6). For normal loading applications, divide the values by 1.6.
3. Reference withdrawal design value of one screw, based on a short-term duration of load (K_D = 1.6).
4. The reference design values are based on the ICC-ES Evaluation Report ESR-3179 for SWG ASSY® 3.0 self-tapping wood screws and the NDS-2015.
5. The minimum spacing, end and edge distances shall be as specified in the ICC-ES Evaluation Report ESR-3179 and the NDS-2015.

REFERENCE DESIGN VALUES, NAILS (lbs)

STEEL THICKNESS (in.)	METAL BRACKET CONNECTIONS[1] 10 NAILS 4-60[2]				STEEL PLATE CONNECTIONS[3] NAIL 4-40 OU 6-60[4]			
	DIAMETER (in. (mm))	LENGTH (in. (mm))	LATERAL (lbs)	WITHDR. (lbs)	DIAMETER (in. (mm))	LENGTH (in. (mm))	LATERAL (lbs)	WITHDR. (lbs)
0.1	0.16 (4)	2.36 (60)	1085	590	n/a	n/a	n/a	n/a
3/16	n/a	n/a	n/a	n/a	0.16 (4)	1.58 (40)	263	105
1/4	n/a	n/a	n/a	n/a	0.24 (6)	2.36 (60)	448	241

NOTES:
1. Simpson Strong-Tie ABR9020 (3-1/2 x 3-1/2 in.) metal brackets.
2. The reference lateral and withdrawal design values for 10 ring shank nails Simpson Strong-Tie CNA4x60 are from the document *Connectors for Cross-Laminated Timber Construction* (L-C-CLTCNCTRS15), provided by the manufacturer. Installation and fastener schedule assume platform framing. The figure below illustrates a typical connection using a metal bracket.
3. Steel plates of 3/16" or 1/4", grade CSA G40.21, designed according to the applicable standards. The minimum spacing, end and edge distances shall be as specified in NDS-2015.
4. The reference lateral and withdrawal design values for 4-40 (diameter of 0.16 in. and length of 1.58 in.) or 6-60 (diameter of 0.24 in. and length of 2.36 in.) nails, for one nail, are based on NDS-2015.
5. The design values are based on a short-term duration of load (K_D = 1.6). For normal loading applications, divide the values by 1.6

ASSY 3.0 SCREW

SIMPSON STRONG-TIE ABR9020

CSA G40.21 STEEL PLATE

RING-SHANK NAIL

ENGINEERING AND
ARCHITECTURAL SERVICES

Nordic Engineered Wood's team consists of engineers, architects and CAD specialists. We provide a full range of architectural and engineering services to help our clients bring their wood construction projects to fruition.

For over 15 years, cross-laminated timber has proven its worth in scores of residential, commercial and industrial projects. A strong, high-performance material, it is well-suited for multi-story construction and has even been used to build the tallest wood buildings in the world. Nordic's range of products can provide effective solutions for most kinds of structures.

From the design to the completion of each wood structure and preassembled wall panel, Nordic works with a variety of competent construction teams to ensure that our clients' projects are finished on time and within budget.

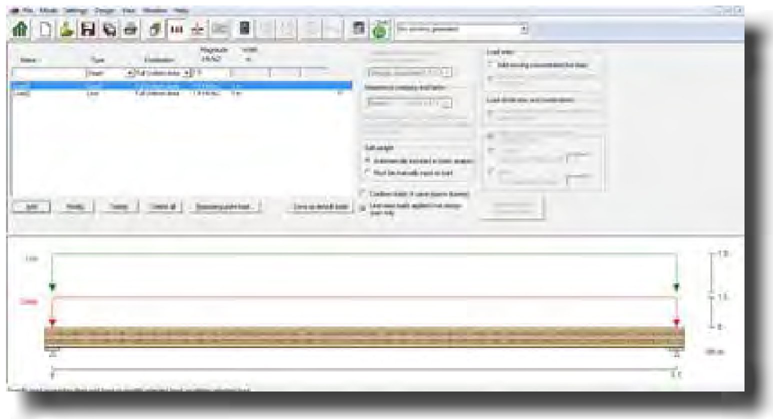
SOFTWARE
NORDIC SIZER

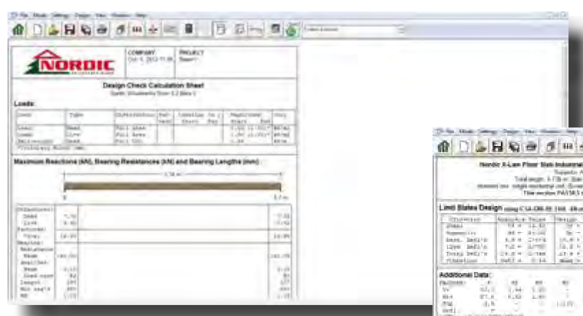
Nordic Sizer is a software program that can be used to design individual members (joists, beams, floor/roof slabs, studs, columns, wall panels) using the full range of Nordic engineered wood products, including **cross-laminated timber**.

Users can analyze and verify simple or multiple span members for dead, live, snow and wind loads, as per **2005 NDS**, and automatically patterns loads and checks all load combinations as per IBC 2009. Joists and beams may be horizontal, sloped or have an oblique angle.

The user may also specify deflection limits, lateral bracing, end notches, web holes, built-up members, service conditions, and floor composition, the latter one for **vibration check.** Material, grade/series, width and thickness may all be specified as 'unknown' – a list of acceptable sections with all the combinations for a given span and loading arrangement will be generated.

Nordic Sizer can be used to analyze and designs columns, studs and wall panels in load-bearing applications; columns may be designed for combined bending and axial loads. The most recent feature is the **fire design** for heavy timber. Designers now have the ability to analyze the fire resistance of heavy timber members based on the NDS-2015.





http://nordic.ca/en/documentation/software

DELIVERY
AND HANDLING

DELIVERY

Delivery of cross-laminated timber panels is arranged once loading plans and delivery dates have been chosen. Cross-laminated timber can be shipped horizontally or on edge. The cost of unloading the truck at the work site is included in our delivery fees, although additional charges may apply if delays occur during unloading.

STORAGE

Basic rules and principles for storing wood also apply to the storage of cross-laminated timber.

LIFTING

We provide lifting aids for use with Nordic X-Lam panels at the factory and on building sites. Depending on the nature and dimensions of the panel, loops, connectors or special screw systems may be used. The required number of lifting aids is determined based on safety requirements and panel dimensions.

ERECTION

Temporary bracing must be used in order to keep the structure stable prior to the permanent installation of load-bearing members. Lifting straps and corner protectors should also be used to avoid damage to the edges of panels.

Video: Condominium project, Chibougamau, Québec (2.5 min):
http://nordic.ca/en/documentation/publications

PORTFOLIO

PORTFOLIO

District 03 – Condominiums
Quebec, Que. (2013)

Gérard-Blanchet Residence
Desbiens, Que. (2011)

Condominium
Chibougamau, Que. (2012)

Recreation centre
Saint-Prime, Que. (2011)

SPECIFICATIONS
FOR LEED

INTRODUCTION

Nordic X-Lam cross-laminated timber (CLT) is manufactured with black spruce in accordance with the E1 grade of ANSI/APA PRG-320, as described in APA Product Report PR-L306. Nordic X-Lam is used as structural members and is manufactured in accordance with the in-plant manufacturing standards approved by APA. The adhesives used to manufacture the CLT products are exterior exposure adhesives meeting the requirements of ANSI 405, and containing no added urea-formaldehyde. The laminating lumber is certified under Forest Stewardship Council Standard FSC-STD-40-004.

GREEN PRODUCTS

Nordic X-Lam CLT products listed above are qualified for green construction with points specified in Table 1, as independently verified by APA[1] as meeting pertinent criteria of the 2009 LEED for New Construction and Major Renovations Standard.

TABLE 1
2009 LEED FOR NEW CONSTRUCTION AND MAJOR RENOVATIONS

Points that have been verified as eligible by APA[1]

	SECTION/CRITERIA	ELIGIBLE POINTS	MAXIMUM POINTS
√	IEQ 4.4: Low Emitting Materials: Composite wood products used on the interior of the building (i.e., inside the weatherproofing system) must contain no added urea-formaldehyde resins	1	1

Eligible points that are conditional on construction location and application

	SECTION/CRITERIA	ELIGIBLE POINTS	MAXIMUM POINTS
√	MR 5: Regional Materials: Use building materials or products that have been extracted, harvested, recovered and processed within 500 miles of the final manufacturing site. Demonstrate that the final manufacturing site is within 500 miles (1,500 miles if shipped by rail or water) of the project site for these products for a minimum of 20% or 30%.	1 pt for 20% and 2 pts for 30%	1 pt for 20% and 2 pts for 30%
√	MR 7: Certified Wood: Use a minimum of 50% (based on cost) of wood-based materials and products that are certified in accordance with the Forest Stewardship Council's Principles and Criteria, for wood building components.	1	1

ADDITIONAL INFORMATION

- Nordic X-Lam is manufactured in the Chantiers Chibougamau Ltd (CCL) facility in Chibougamau, Quebec.
- CCL uses source materials, i.e. lumber, that have been extracted, harvested, recovered and processed within 500 miles of the final manufacturing site. The mean harvesting distance is 60 miles, and the farthest distance 150 miles.
- Nordic X-Lam is made of 96% (by weight) of wood fiber; the other components include resins (no added urea-formaldehyde resins).
- LEED IEQ Credit 4.1, Low-emitting Materials: Adhesives and sealants - *Not applicable*
- LEED MR Credit 3, Materials Reuse - *Not applicable*

SUPPORTING DATA

- [1]APA Green Verification Report GR-L306, Nordic X-Lam
- FSC SW-CW/FM-003874 Forest Management and SW-COC-CW-003885 Chain-of-Custody (CCL)
- FSC SW-COC-004084 Chain-of-Custody (Nordic)

ONE SMALL STEP FOR NORDIC

ONE GIANT STEP
FOR INDUSTRY

From its inception Nordic has strived to provide the most efficient wood products with the least environmental impacts. That's why Nordic, in its exclusive partnership with Chantiers Chibougamau Ltd., has become a leader in demanding well-managed forestry practices.

Back in 2000, Nordic was one of the first in North America to demand that the wood used in its products meet or exceed the ISO 14001 Standard. Continuing its ongoing commitment to responsible wood solutions, Nordic is proud to offer products that are certified by the Forest Stewardship Council, the international benchmark of well-managed forests.

What's in a logo?

With all the certification bodies out there, trying to do the right thing and buying responsibly produced products can be confusing. The FSC label makes it easy to make the right choice when buying wood products. This is what sets FSC apart:

Only FSC

- prohibits conversion of natural forests or other habitat around the world
- prohibits the use of highly hazardous pesticides around the world
- respects human rights with particular attention to indigenous peoples
- is the only forest ***certification system*** that is supported by all major environmental groups.
- identifies areas that need special protection (e.g. cultural or sacred sites, habitats of endangered animals or plants.

But most importantly only FSC reviews each certified operation ***at least*** once a year – and if they are found not to comply, the certificate is withdrawn.

> **"FSC has the highest environmental standard for forest management of any certification system in the world."**
>
> Monte Hummel
> *World Wildlife Fund, Canada*

Protecting nature's resources is everyone's responsibility; at Nordic we are doing our part.

Do yours.

FSC-Certified wood products are available. Consult your local distributor for details.

FSC
www.fsc.org

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HEAD OFFICE AND TECHNICAL SERVICES
info@nordicewp.com
T. 514.871.8526 • F. 514.871.9789

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