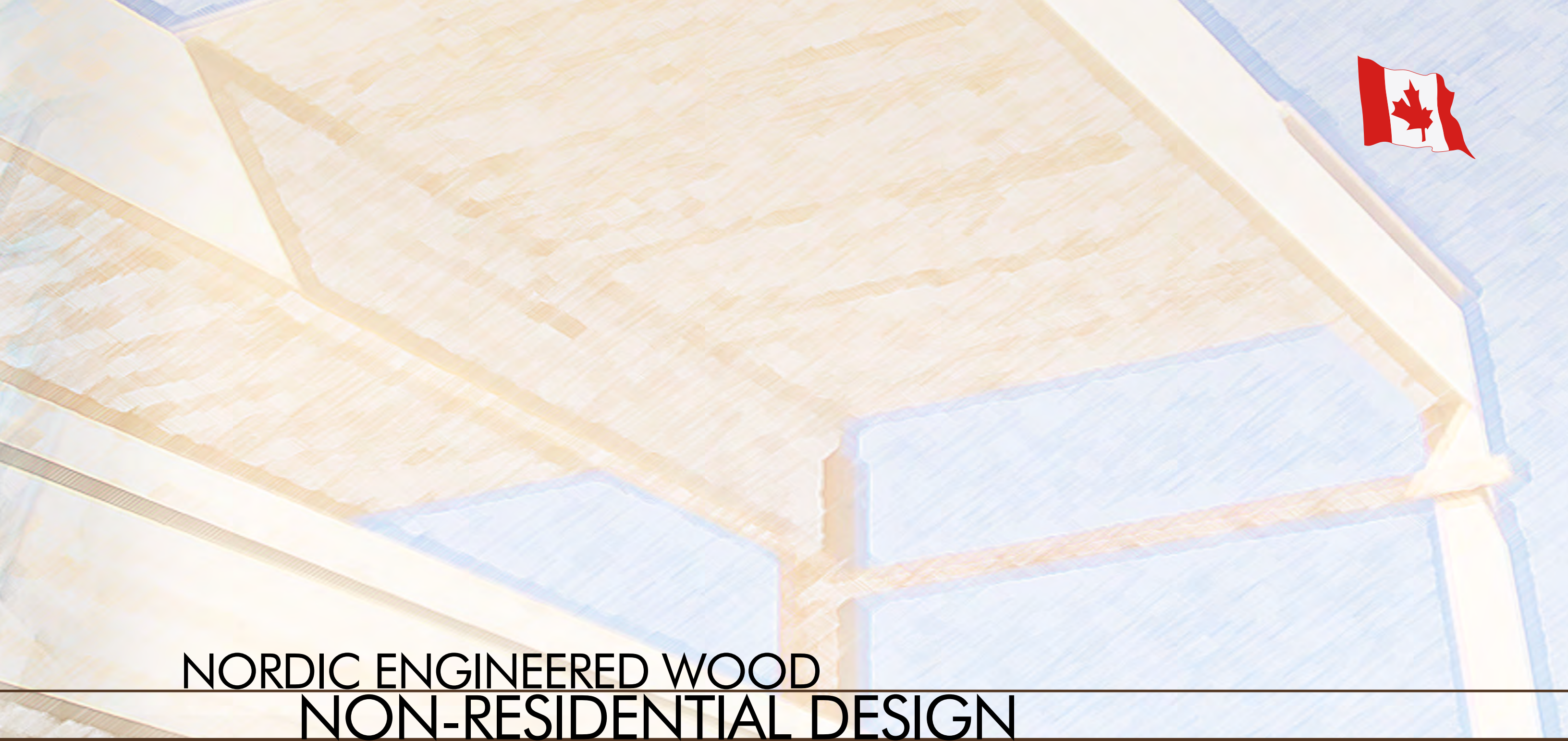

NORDIC ENGINEERED WOOD

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

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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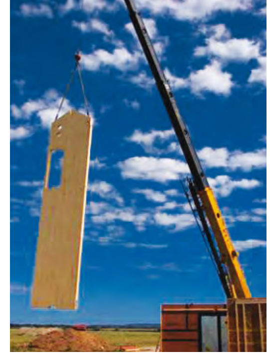
THE ADVANTAGES
OF WOOD CONSTRUCTION



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.

FSC www.fsc.org

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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

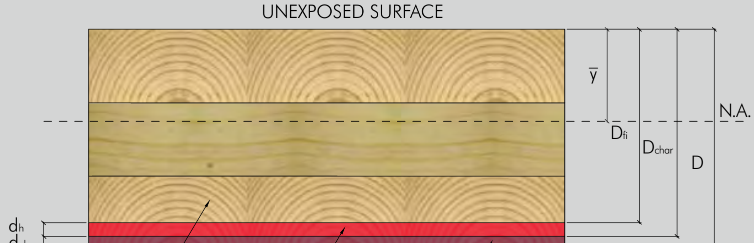
The remarkable structural resistance of cross-laminated timber makes it suitable for single- and multiple-unit residences and public buildings as well as offices, schools, and industrial and commercial projects. An increasingly popular choice due to its load-bearing properties and its exceptional quality, 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 0.65 mm per minute, 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 19 mm 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 19 mm when measured in the direction of the lamination length with the exception that a void may be longer than 19 mm if its area is not greater than 323 mm^2.
- Voids greater than 1.6 mm 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 **SECTION 06 18 00**

SPEC NOTE: This Section includes only those items specific to Nordic cross-laminated timber (Nordic X-Lam).

1. GENERAL

- **References**
  - o Canadian Construction Material Centre (CCMC): CCMC's *Registry of Product Evaluations,* October 1st, 2000 On-line Edition (updated quarterly).
- **Information submittals**
  - o Certifications: Submit the material evaluation listing listed in the *Registry of Product Evaluations* published by the CCMC at completion of fabrication.
- **Quality assurance**
  - o Qualifications:
    - Manufacture structural members in a plant that is certified as meeting the requirements of a certification agency accredited by the Standards Council of Canada.
    - Submit the material evaluation listing listed in the *Registry of Product Evaluations* published by the CCMC at completion of fabrication.
    - Place, on members, the material evaluation listing number listed in the *Registry of Product Evaluations* published by the CCMC indicating manufactured in certified plant.

2. PRODUCTS

- **Materials**
  - o Cross-laminated timber: Spruce-Pine-Fir, FSC Certified, to the material evaluation listing listed in the *Registry of Product Evaluations* published by CCMC.
- **Fabrication**
  - o Stress grade: Bending, compression and/or tension members E1, to the material evaluation listing listed in the *Registry of Product Evaluations* published by the CCMC.
  - o Service grade: Interior
  - o Appearance grade: [Industrial] [Architectural]

3. EXECUTION

- **Erection**
  - o Erect cross-laminated members in accordance with erection drawings issued for construction.

For complete editable specification guide:
http://nordic.ca/en/documentation/technical-documents/t-s09

For CCMC evaluation listing:
http://nordic.ca/en/documentation/technical-documents/apa-pr-l306c

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

Design of CLT shearwalls and diaphragms shall be conducted using the methods of mechanics, assuming the CLT wall and diaphragm panels and segments as rigid bodies. The seismic force modification factors R_d of 2.0 and R_0 of 1.5 are recommended. For more details, refer to Chapter 4 of CLT Handbook.

Wall panels

Only the layers parallel to the axial load shall be taken into account. The shear resistances 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 published strengths and an effective cross-section based on the layers perpendicular to the load.

Duration of load and creep

The equation specified in Clause 4.3.2.3 of CSA O86-09 shall be used for calculating the duration of load factor, K_D. The use of a 25% reduction in shear stiffness is recommended when checking the elastic deflection limit under total load and a 50% reduction in shear stiffness for the permanent deformation limit in order to account for the deformations caused by shear perpendicular to grain (rolling shear). 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.

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, 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_b MSR	No. 3/Stud
Bending at extreme fibre, f_b (MPa)	28.2	7.0
Longitudinal shear, f_v (MPa)	1.5	1.5
Rolling shear, f_s (MPa)	0.5	0.5
Compression parallel to grain, f_c (MPa)	19.3	9.0
Compression perp. to grain, f_{cp} (MPa)	5.3	5.3
Tension parallel to grain, f_t (MPa)	15.4	3.2
Modulus of elasticity, E_0 (MPa)	11 700	9000
Shear modulus, G_0 (MPa)	731	563
Rolling shear modulus, G_s (MPa)	73.1	56.3

DESIGN PROPERTIES
SLABS

FACTORED RESISTANCES AND RIGIDITIES – 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, $M_{r,0}$ (10^6 N-mm/m)	21	38	49	87	134	199	308
Shear, $V_{r,0}$ (10^3 N/m)	23	30	31	42	51	68	82
Bending rigidity, $EI_{eff,0}$ (10^9 N-mm^2/m)	452	1081	1735	4140	8019	13 194	26 272
Shear rigidity, $GA_{eff,0}$ (10^6 N/m)	5.4	7.3	11	15	22	31	37
Bending about the minor strength axis							
Bending moment, $M_{r,90}$ (10^6 N-mm/m)	0.76	1.3	6.4	11	18	11	25
Shear, $V_{r,90}$ (10^3 N/m)	8.0	10	23	30	33	30	41
Bending rigidity, $EI_{eff,90}$ (10^9 N-mm^2/m)	14	32	363	831	1884	831	3163
Shear rigidity, $GA_{eff,90}$ (10^6 N/m)	6.9	9.0	14	18	22	28	37

(1) The tabulated design values are for dry service conditions and standard term duration of load. The factored resistance values, M_r and V_r, include the resistance factor, ∅.
(2) Nordic X-Lam bending panels are symmetrical throughout the depth of the member (balanced layups).
(3) The compression perpendicular to grain values are based on S-P-F No. 3/Stud lumber (f_{cp} = 5.3 MPa).
(4) The factored resistances were derived analytically using the shear analogy model[1] and validated by testing (the calculated moment resistances in the major strength axis were further multiplied by a factor of 0.85 for conservatism). The design of cross-laminated timber members shall be in accordance to CSA O86-09 and the CLT Handbook.
(5) The specific gravity for dowel-type fastener design, G, is 0.42. Member weight shall be based on density of 515 kg/m^3 (5.1 kN/m^3).

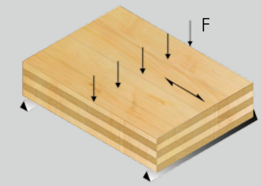
** Nordic X-Lam products are certified by APA (Product Report PR-L306C), per the ANSI/APA PRG 320 Standard.*
[1] Gagnon, S. and M. Popovski. 2011. CLT Handbook. FPInnovations, Canada. http://www.masstimber.com/products/cross-laminated-timber-clt/handbook/modules

PANEL LAYUPS

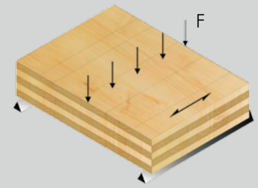
PRODUCT	COMPOSITION (L = longitudinal, T = transversal)	NUMBER OF PLIES	THICKNESS (mm)	THICKNESS (in.)	WEIGHT (kPa)
78-3s	26L - 27T - 26L	3	78	3-1/8	0.40
105-3s	35L - 35T - 35L	3	105	4-1/8	0.53
131-5s	26L - 27T - 26L - 27T - 26L	5	131	5-1/8	0.67
175-5s	35L - 35T - 35L - 35T - 35L	5	175	6-7/8	0.89
220-7s	35L - 27T - 35L - 27T - 35L - 27T - 35L	7	220	8-5/8	1.12
244-7l	35L - 35L - 35T - 35L - 35T - 35L - 35L	7	244	9-5/8	1.24
314-9l	35L - 35L - 35T - 35L - 35T - 35L - 35T - 35L - 35L	9	314	12-3/8	1.60

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-l306c

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 modification factor is given in brackets):

1. **Is load duration "standard" (K_D)?**
   K_D is a load duration factor. The tables are based on a standard term load (K_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" (K_S)?**
   K_S is a service condition factor. The tables are limited to dry service conditions (K_S = 1.0).

3. **Is the material free of incising and/or strength-reducing chemicals (K_T)?**
   K_T is a treatment factor. The tables are based on untreated timber (K_T = 1.0).

4. **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 specified total load and span/360 under specified live load. For other deflection limits, multiply the values accordingly.

5. **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 maximum floor spans on page 16.

6. **Should creep effects be considered?**
   A 25% reduction in shear stiffness has been used when checking the elastic deflection limit due to total load in order to account for the deformations caused by shear perpendicular to grain (rolling shear) and creep.

7. **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 4.1.5.9 of the 2010 NBCC) or other non-uniform loading. In these cases refer to CSA O86-09 and the CLT Handbook.

If the answer to any of those questions in no, consult Nordic. Otherwise, the Slab Selection Tables may be used directly. The selection tables provide the maximum uniform specified total or live load, $w_{\Delta R}$, 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 panel self weight has not been considered in the calculation of maximum loads (i.e. it shall be included in the specified total load). Consult Nordic for other options.

SLABS
SIZING

DEFLECTION CRITERIA L/240 UNDER SPECIFIED TOTAL LOAD
SLAB THICKNESS (mm)

<table>
<tr><th rowspan="2">TL
(kPa)</th><th colspan="7">SIMPLE SPAN (m)</th><th colspan="7">DOUBLE SPAN (m)</th></tr>
<tr><th>3.5</th><th>4.0</th><th>4.5</th><th>5.0</th><th>5.5</th><th>6.0</th><th>6.5</th><th>3.5</th><th>4.0</th><th>4.5</th><th>5.0</th><th>5.5</th><th>6.0</th><th>6.5</th></tr>
<tr><td>2.0</td><td rowspan="3">78</td><td>78</td><td rowspan="3">105</td><td rowspan="2">105</td><td rowspan="3">131</td><td>131</td><td rowspan="5">175</td><td rowspan="5">78</td><td rowspan="2">78</td><td>78</td><td rowspan="4">105</td><td rowspan="2">105</td><td>105</td><td rowspan="2">131</td></tr>
<tr><td>2.5</td><td rowspan="5">105</td><td rowspan="6">175</td><td rowspan="5">105</td><td rowspan="2">131</td></tr>
<tr><td>3.0</td><td rowspan="3">131</td><td rowspan="8">105</td><td rowspan="3">131</td><td rowspan="7">175</td></tr>
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<tr><td>4.0</td><td rowspan="4">131</td></tr>
<tr><td>4.5</td><td rowspan="8">175</td><td rowspan="8">220</td><td rowspan="8">105</td><td rowspan="8">175</td></tr>
<tr><td>5.0</td><td rowspan="6">131</td><td rowspan="6">131</td></tr>
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<tr><td>6.5</td><td rowspan="4">220</td></tr>
<tr><td>7.0</td><td rowspan="3">131</td><td rowspan="3">220</td><td rowspan="3">131</td></tr>
<tr><td>7.5</td></tr>
<tr><td>8.0</td><td>175</td><td>175</td><td>220</td></tr>
</table>

DEFLECTION CRITERIA L/360 UNDER SPECIFIED LIVE LOAD
SLAB THICKNESS (mm)

<table>
<tr><th rowspan="2">LL
(kPa)</th><th colspan="7">SIMPLE SPAN (m)</th><th colspan="7">DOUBLE SPAN (m)</th></tr>
<tr><th>3.5</th><th>4.0</th><th>4.5</th><th>5.0</th><th>5.5</th><th>6.0</th><th>6.5</th><th>3.5</th><th>4.0</th><th>4.5</th><th>5.0</th><th>5.5</th><th>6.0</th><th>6.5</th></tr>
<tr><td>2.0</td><td>78</td><td rowspan="3">105</td><td>105</td><td rowspan="2">131</td><td>131</td><td rowspan="4">175</td><td rowspan="2">175</td><td rowspan="2">78</td><td>78</td><td rowspan="3">105</td><td>105</td><td rowspan="2">131</td><td>131</td><td rowspan="5">175</td></tr>
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<tr><td>3.0</td><td rowspan="7">175</td><td rowspan="6">220</td><td rowspan="8">105</td><td rowspan="8">175</td></tr>
<tr><td>3.5</td><td rowspan="4">131</td><td rowspan="4">131</td></tr>
<tr><td>4.0</td><td rowspan="9">175</td><td rowspan="7">220</td><td rowspan="9">175</td></tr>
<tr><td>4.5</td><td rowspan="7">220</td></tr>
<tr><td>5.0</td><td rowspan="6">131</td><td rowspan="7">220</td><td rowspan="5">131</td></tr>
<tr><td>5.5</td><td rowspan="6">175</td><td rowspan="6">175</td><td rowspan="6">220</td></tr>
<tr><td>6.0</td><td rowspan="5">244</td></tr>
<tr><td>6.5</td><td rowspan="4">220</td></tr>
<tr><td>7.0</td><td rowspan="3">131</td><td rowspan="3">220</td></tr>
<tr><td>7.5</td><td rowspan="2">244</td><td rowspan="2">175</td></tr>
<tr><td>8.0</td><td>175</td><td>244</td></tr>
</table>

NOTES:

1. Sizing (panel thickness shown in millimetres) 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 CSA O86-09 and the CLT Handbook. Final design shall include a complete analysis including the verification of the bearing resistance, a consideration for the floor vibrations if applicable, and fire safety requirements.
3. Tables are based on uniform loads, dry-use conditions and standard term load duration, for bending about the major strength axis of the panel. Span is measured centre to centre of supports.
4. The loads indicated above are the uniform specified total load (TL) or live load (LL). The panels self weight is not considered and shall be included in the specified total load calculation.
5. Maximum deflection = L/240 under specified total load or L/360 under specified live load. Other deflection limits may apply. A 25% reduction in shear stiffness has been used when checking the elastic deflection under total load in order to account for the deformations caused by rolling shear.

SLABS
SELECTION TABLES
E1

SERVICEABILITY LIMIT STATES – L/240, SIMPLE SPAN

MAXIMUM SPECIFIED UNIFORM <u>TOTAL LOAD</u> $W_{\Delta R}$ (kPa)

SPAN (m)	LAYUP COMBINATION						
	78-3s	105-3s	131-5s	175-5s	220-7s	244-7l	314-9l
3.0	4.69	10.2					
3.2	3.92	8.64					
3.4		7.36	11.6				
3.6		6.31	10.0				
3.8		5.45	8.64				
4.0		4.73	7.52				
4.2		4.14	6.57				
4.4		3.63	5.78				
4.6			5.11	11.3			
4.8			4.53	10.1			
5.0			4.04	9.01			
5.2			3.62	8.10			
5.4				7.31			
5.6				6.61			
5.8				6.00	11.2		
6.0				5.46	10.3		
6.2				4.99	9.38		
6.4				4.56	8.59		
6.6				4.18	7.89		
6.8				3.85	7.27		
7.0				3.54	6.70	10.9	
7.2					6.19	10.1	
7.4					5.74	9.31	
7.6					5.32	8.65	
7.8					4.94	8.04	
8.0					4.60	7.49	
8.2					4.29	6.98	
8.4					4.01	6.52	
8.6					3.75	6.10	11.5
8.8					3.51	5.72	10.8
9.0						5.36	10.2
9.2						5.04	9.57
9.4						4.74	9.02
9.6						4.46	8.50
9.8						4.20	8.03

NOTES:

1. A complete design shall include the verification of the resistance, a consideration for floor vibration when applicable (in this case, refer to page 16 for the maximum spans), and fire safety requirements.
2. A 25% reduction in shear stiffness has been used in order to account for the deformation caused by rolling shear and for creep.

E1

SERVICEABILITY LIMIT STATES – L/240, DOUBLE SPAN

MAXIMUM SPECIFIED UNIFORM <u>TOTAL LOAD</u> $W_{\Delta R}$ (kPa)

SPAN (m)	LAYUP COMBINATION						
	78-3s	105-3s	131-5s	175-5s	220-7s	244-7l	314-9l
3.0	6.57						
3.2	5.50	12.0					
3.4	4.65	10.3					
3.6	3.96	8.82					
3.8	3.40	7.62	12.1				
4.0		6.63	10.5				
4.2		5.80	9.21				
4.4		5.10	8.11				
4.6		4.51	7.17				
4.8		4.00	6.37				
5.0		3.57	5.68				
5.2			5.09	11.3			
5.4			4.57	10.2			
5.6			4.12	9.26			
5.8			3.73	8.41			
6.0				7.66			
6.2				7.00			
6.4				6.40			
6.6				5.88	11.1		
6.8				5.40	10.2		
7.0				4.98	9.40		
7.2				4.60	8.69		
7.4				4.26	8.05		
7.6				3.94	7.47		
7.8				3.66	6.95	11.3	
8.0					6.47	10.5	
8.2					6.03	9.81	
8.4					5.63	9.17	
8.6					5.27	8.58	
8.8					4.94	8.04	
9.0					4.63	7.54	
9.2					4.35	7.08	
9.4					4.09	6.66	
9.6					3.85	6.27	
9.8					3.63	5.92	11.3

NOTES:

1. A complete design shall include the verification of the resistance, a consideration for floor vibration when applicable (in this case, refer to page 16 for the maximum spans), and fire safety requirements.
2. A 25% reduction in shear stiffness has been used in order to account for the deformation caused by rolling shear and for creep.

E1

SERVICEABILITY LIMIT STATES – L/360, SIMPLE SPAN

MAXIMUM SPECIFIED UNIFORM LIVE LOAD $W_{\Delta R}$ (kPa)

SPAN (m)	LAYUP COMBINATION						
	78-3s	105-3s	131-5s	175-5s	220-7s	244-7l	314-9l
3.0	3.23	7.18					
3.2	2.69	6.04					
3.4	2.26	5.11	8.12				
3.6	1.92	4.37	6.94				
3.8		3.76	5.98				
4.0		3.26	5.18				
4.2		2.84	4.52				
4.4		2.49	3.97				
4.6		2.19	3.50	7.85			
4.8		1.94	3.10	6.98			
5.0			2.76	6.24			
5.2			2.46	5.60			
5.4			2.21	5.04			
5.6			1.99	4.55			
5.8				4.12	7.78		
6.0				3.74	7.08		
6.2				3.41	6.46		
6.4				3.12	5.91		
6.6				2.85	5.42		
6.8				2.62	4.98		
7.0				2.41	4.59	7.46	
7.2				2.22	4.23	6.89	
7.4				2.06	3.92	6.38	
7.6					3.63	5.91	
7.8					3.37	5.49	
8.0					3.13	5.11	
8.2					2.92	4.76	
8.4					2.72	4.44	
8.6					2.54	4.15	
8.8					2.38	3.89	7.44
9.0					2.23	3.64	6.99
9.2					2.09	3.42	6.57
9.4					1.96	3.21	6.18
9.6						3.02	5.82
9.8						2.85	5.49

NOTE:

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

E1

SERVICEABILITY LIMIT STATES – L/360, DOUBLE SPAN

MAXIMUM SPECIFIED UNIFORM LIVE LOAD $W_{\Delta R}$ (kPa)

SPAN (m)	LAYUP COMBINATION						
	78-3s	105-3s	131-5s	175-5s	220-7s	244-7l	314-9l
3.0	4.53						
3.2	3.78	8.44					
3.4	3.18	7.16					
3.6	2.71	6.12					
3.8	2.32	5.27					
4.0	2.00	4.57	7.27				
4.2		3.99	6.35				
4.4		3.50	5.57				
4.6		3.08	4.92				
4.8		2.73	4.36				
5.0		2.43	3.88				
5.2		2.17	3.47	7.85			
5.4		1.95	3.11	7.07			
5.6			2.80	6.39			
5.8			2.53	5.79			
6.0			2.30	5.26			
6.2			2.09	4.80			
6.4				4.38			
6.6				4.02	7.61		
6.8				3.69	7.00		
7.0				3.40	6.45		
7.2				3.13	5.95		
7.4				2.89	5.51		
7.6				2.68	5.11		
7.8				2.49	4.74	7.72	
8.0				2.31	4.41	7.19	
8.2				2.15	4.11	6.70	
8.4				2.01	3.83	6.25	
8.6					3.58	5.85	
8.8					3.35	5.47	
9.0					3.14	5.13	
9.2					2.95	4.82	
9.4					2.77	4.53	8.68
9.6					2.61	4.26	8.18
9.8					2.45	4.01	7.72

NOTE:

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

E1

SERVICEABILITY LIMIT STATES – VIBRATION CRITERIA
1.5 kPa DEAD LOAD
MAXIMUM SPANS ℓ_{max} (m)

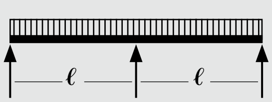
RATIO	COMBINATION						
	78-3s	105-3s	131-5s	175-5s	220-7s	244-7l	314-9l
ENHANCED CRITERIA							
Ratio 1:1	2.03	3.13	4.82	5.85	6.74	7.55	8.70
Ratio 1:2	2.03	3.13	5.06	6.59	7.60	8.50	9.8
Ratio 1:3	2.03	3.13	5.06	6.74	7.77	8.70	10.0
ENHANCED CRITERIA							
Ratio 1:1	1.44	2.21	3.58	5.06	5.84	6.54	7.53
Ratio 1:2	1.44	2.21	3.58	5.50	6.58	7.37	8.49
Ratio 1:3	1.44	2.21	3.58	5.50	6.73	7.54	8.69

SERVICEABILITY LIMIT STATES – VIBRATION CRITERIA
2.5 kPa DEAD LOAD
MAXIMUM SPANS ℓ_{max} (m)

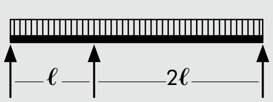
RATIO	COMBINATION						
	78-3s	105-3s	131-5s	175-5s	220-7s	244-7l	314-9l
ENHANCED CRITERIA							
Ratio 1:1	2.03	3.13	4.38	5.36	6.22	6.98	8.11
Ratio 1:2	2.03	3.13	4.94	6.04	7.00	7.87	9.14
Ratio 1:3	2.03	3.13	5.05	6.18	7.17	8.05	9.35
ENHANCED CRITERIA							
Ratio 1:1	1.44	2.21	3.58	4.64	5.38	6.05	7.02
Ratio 1:2	1.44	2.21	3.58	5.23	6.07	6.81	7.91
Ratio 1:3	1.44	2.21	3.58	5.35	6.21	6.97	8.10

NOTES:

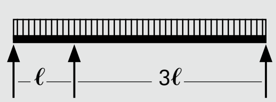
1. The maximum spans are based on a dead load of 1.5 or 2.5 kPa in addition to the panel self weight.
2. The ratios represent the span ratios (see figures below). For a simple span, use a ratio of 1:1.
3. The maximum spans are based on Hamm-Richter-Winter design method to control floor vibrations and 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 maximum spans only consider floor vibration criteria.



Ratio 1:1



Ratio 1:2



Ratio 1:3

SLABS

EXAMPLE: **ROOF SLAB**

Roof slab

Given a slab of 105 mm (105-3s); self weight = 0.53 kPa
Specified dead load = 2.0 kPa (including slab self weight)
Specified snow load for serviceability calculations = 2.0 kPa
Beam spacing (span) = 5.0 m
Dry service condition, untreated lumber, double span pattern
Deflection limits: L/240 based on live load, L/180 based on total load

Deflection criteria check

Specified live (snow) load w_L = 2.0 kPa
Specified total load w = 2.0 + 2.0 = 4.0 kPa

Using the appropriate deflection adjustments:
$w_{\Delta R}$ = (360/240) x 2.43 = 3.64 kPa > 2.0 kPa for L/240 deflection (live load) √ Table $w_{\Delta R}$, L/360, double span
$w_{\Delta R}$ = (240/180) x 3.57 = 4.74 kPa > 4.0 kPa for L/180 deflection (total load) √ Table $w_{\Delta R}$, L/240, double span

Use E1 105-3s, 105 mm thick slab.

Note: A complete design shall include the verification of bending and bearing resistances. Where slabs are used to support roof loads, the maximum spans for slabs may be limited by the NBCC roof point load requirements (refer to 2010 NBCC, article 4.1.5.9).

EXAMPLE: **FLOOR SLAB**

Floor slab

Given a slab of 175 mm (175-5s); self weight = 0.96 kPa ~ 1.0 kPa
Specified dead load = 2.5 kPa (including slab self weight)
Specified live load = 1.9 kPa
Beam spacing (span) = 5.85 m
Dry service condition, untreated lumber, simple span pattern
Deflection limits: L/360 based on live load, L/240 based on total load; standard vibration criteria

Serviceability criteria check

Specified dead load excluding slab self weight w_D = 1.5 kPa
Specified live load w_L = 1.9 kPa
Specified total load w = 2.5 + 1.9 = 4.4 kPa

$w_{\Delta R}$ = 3.74 kPa > 1.9 kPa for L/360 deflection (live load)	√	Table $w_{\Delta R}$, L/360, simple span
$w_{\Delta R}$ = 5.46 kPa > 4.4 kPa for L/240 deflection (total load)	√	Table $w_{\Delta R}$, L/240, simple span
ℓmax = 5.85 m > 5.85 m for simple span (ratio 1:1)	√	Table ℓmax, 1.5 kPa, standard cr.

Use E1 175-5s, 175 mm thick slab.

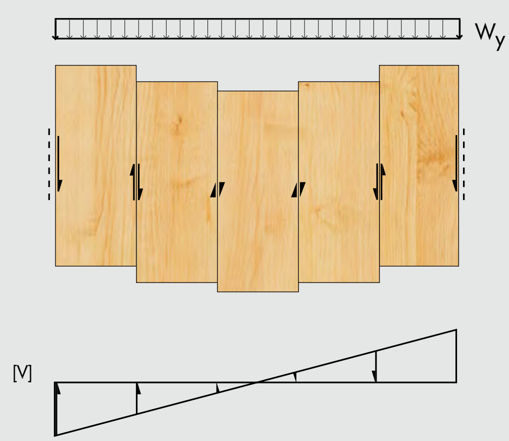
Note: A complete design shall include among other things the verification of a concentrated live load (if applicable), bending and bearing resistances, and fire safety requirements.

DIAPHRAGMS

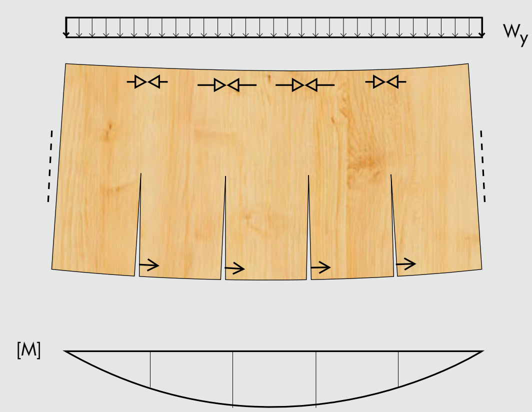
Sufficiently rigid diaphragms are paramount for the overall building rigidity. Diaphragms are created by joining the adjacent slab segments to each other along their edges using metal fasteners, such as screws. A continuous floor/roof diaphragm is necessary to correctly distribute lateral loads to supporting 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

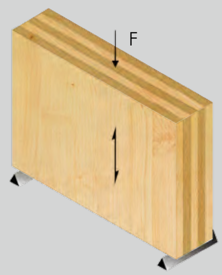
FACTORED RESISTANCES AND RIGIDITIES – walls and lintels

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, $P_{r,0}$ (10^3 N/m)	797	1078	1195	1618	2157	2696	3235
Tension, $T_{r,0}$ (10^3 N/m)	715	968	1073	1452	1936	2420	2904
Effective area, A_{eff} (10^3 mm²/m)	52	70	77	105	140	175	210
Effective inertia, I_{eff} (10^6 mm⁴/m)	39	92	147	351	680	1125	2236
Radius of gyration, r_{eff} (mm/m)	27	36	44	58	70	80	103
In-plane shear, $V_{r,0}$ (10^3 N/m)	86	95	168	190	257	284	379
Loaded to minor strength axis							
Compression, $P_{r,90}$ (10^3 N/m)	193	251	386	503	579	503	754
Tension, $T_{r,90}$ (10^3 N/m)	77	101	154	201	232	201	302
Effective area, A_{eff} (10^3 mm²/m)	27	35	54	70	80	70	105
Effective inertia, I_{eff} (10^6 mm⁴/m)	1.6	3.5	40	92	209	92	351
Radius of gyration, r_{eff} (mm/m)	7.7	10	27	36	51	36	58
In-plane shear, $V_{r,90}$ (10^3 N/m)	86	95	168	190	257	284	379

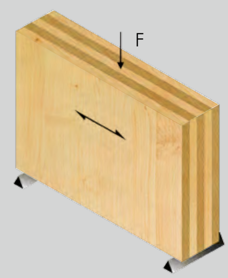
(1) The tabulated design values are for dry service conditions and standard term duration of load. The factored resistance values, P_r, T_r and V_r, include the resistance factor, Ø.
(2) Nordic X-Lam bending panels are symmetrical throughout the thickness of the member (balanced layups).
(3) The compression parallel to grain resistance values, P_r, shall be adjusted by the size and slenderness factors, K_{Zc} and K_c, respectively, as defined in CSA O86-09.
(4) The compression perpendicular to grain values shall be based on S-P-F No. 3/Stud lumber (f_{cp} = 5.3 MPa).
(5) The bending moment resistance and stiffness shall be based on S-P-F No. 3/Stud (f_b = 7.0 MPa, E = 9000 MPa) or S-P-F MSR 1950Fb (f_b = 28.2 MPa, E = 11,700 MPa) 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 resistances, V_r, are given in kN/m of member height. These values are based on the TUGraz study with the specified strengths $f_{v,clt,k}$ = 5.0 MPa and $f_{t,clt,k}$ = 2.5 MPa, adjusted with the following factors: k_{mod} = 0.8 and γ_M = 1.25. (Ref. BSPhandbuch, TUGraz)
(7) The design of cross-laminated timber members shall be in accordance to CSA O86-09 and the CLT Handbook.
(8) The specific gravity for dowel-type fastener design, G, is 0.42. Member weight shall be based on density of 515 kg/m³ (5.1 kN/m³).

** Nordic X-Lam products are certified by APA (Product Report PR-L306C), 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-l306c

WALLS

To verify that the tabulated resistances 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 "standard" (K_D)?**
   K_D is a load duration factor. The tabulated resistances are based on a standard term load (K_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"(K_S)?**
   K_S is a service condition factor. The tables are limited to dry service conditions (K_S = 1.0).

3. **Is the material free of incising and/or strength-reducing chemicals (K_T)?**
   K_T is a treatment factor. The tables are based on untreated timber (K_T = 1.0).

4. **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?**

5. **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 CSA O86-09, Clause 5.5.6. Information on eccentrically loaded walls is provided in the CLT Handbook. Note that in certain cases the National Building Code of Canada permits a reduction in the loads due to use and occupancy depending upon the size of the tributary area (refer to Article 4.1.5.8 of the 2010 NBCC).

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
SELECTION TABLES

ULTIMATE LIMIT STATES – ECCENTRICITY OF 1/6
MAXIMUM UNIFORM LOAD P_R (kN/m)

L (m)	MAJOR STRENGTH AXIS				MINOR STRENGTH AXIS	
	LAYUP COMBINAISON				LAYUP COMBINAISON	
	78-3s	105-3s	131-5s	175-5s	220-7s	244-7l
2.0	382	644	768	1121	149	223
2.5	295	548	688	1057	125	201
3.0	224	454	601	981	102	177
3.5	170	371	515	896	81	153
4.0	130	302	437	807	65	131
4.5		246	369	720		111
5.0		200	311	638		94
5.5			262	562		
6.0			221	495		
6.5			187	435		
7.0				382		
7.5				336		
8.0				296		
8.5				261		
9.0						

ULTIMATE LIMIT STATES – CONCENTRIC END LOADS
MAXIMUM UNIFORM LOAD P_R (kN/m)

L (m)	MAJOR STRENGTH AXIS				MINOR STRENGTH AXIS	
	LAYUP COMBINAISON				LAYUP COMBINAISON	
	78-3s	105-3s	131-5s	175-5s	220-7s	244-7l
2.0	517	877	1055	1531	269	424
2.5	388	744	948	1456	209	368
3.0	282	607	824	1357	156	308
3.5	204	483	697	1239	116	251
4.0	150	379	578	1111	86	201
4.5		298	475	981		160
5.0		235	388	856		128
5.5			317	741		
6.0			260	638		
6.5			214	548		
7.0						
7.5				470		
8.0				404		
8.5				348		
9.0				301		

NOTES:
1. The tabulated axial resistances 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.
2. Values shown are the maximum uniform loads, in kN/m, that can be applied to the wall in addition to its own weight.
3. For L ≤ 2,0 m, use P_r for L = 2,0 m. Where P_r values are not given, the slenderness ratio exceeds 150 (maximum permitted).
4. A complete design shall include the verifications of bearing resistance and fire safety requirements.
5. L = unsupported length

SHEARWALLS

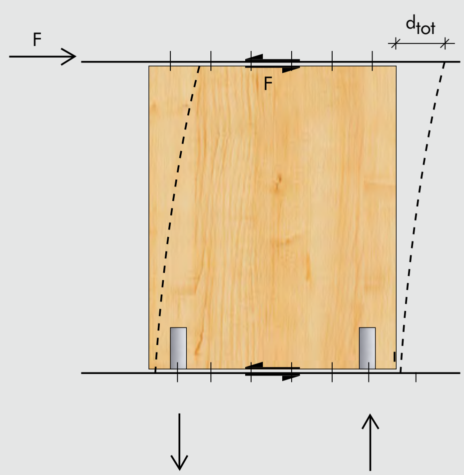
The lateral deflection, or storey drift, shall be limited to h/300, where h is the storey height. It is however strongly recommended to limit storey drift to h/500. As shown in the figure below, the total lateral deflection is a result of wall panel bending and shear deformation, and tensile and shear 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 2438 mm (8 feet); including the lapped-joint of 64 mm - Lengths up to 19.5 metres (64 feet) - Thicknesses from 78 to 381 mm (3 to 15 in.); standard 78 (3-1/8), 105 (4-1/8), 131 (5-1/8), 175 (6-7/8), 220 (8-5/8), 244 (9-5/8), and 314 mm (12-3/8 in.)
Appearance grade	Industrial (architectural upon request)
Joint profile	64 mm (2-1/2 in.) width lapped joint, on both sides
Certification	APA Product Report PR-L306C; FSC certified products available
Lumber species	Spruce-Pine-Fir (S-P-F)
Lamellas	Longitudinal lamellas 1950F_b MSR, transversal No. 3/Stud
Adhesives	Weatherproof adhesives, formaldehyde free; low volatile organic compounds (VOC) limits.
Density	± 515 kg/m^3, 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	RSI = 0.83 m^2 °C/W, R = 4.7 ft^2 h °F/BTU per 100 mm
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. - Charring rate of 0,65 mm/min.; see fire-resistance ratings (FRR) for typical assemblies. - The flame spread and smoke developed classifications are 35 and 40, respectively (tests report available upon request).
Environmental performance	- Available readily manufactured from wood certified as harvested from sustainable managed forests - Long-term storage of the carbon absorbed by the sustainable 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 (RSI)	0.83 m^2 °C/W
Heat conductivity (λ)	0.12 W/m•K
Density (ρ)	515 kg/m^3

VAPOUR DIFFUSION CONTROL

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

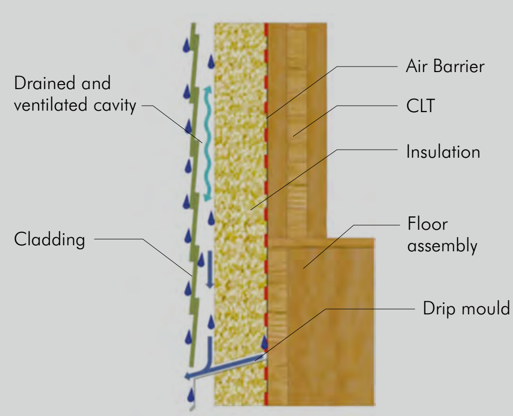
However, the low vapour permeability of cross-laminated timber (less than 30 ng/pa•s•m^2 for a 90 mm-thick panel) ensures that in most situations, moisture flow is controlled by the timber itself. Because the materials on the structure's exterior must be sufficiently vapour permeable so as not to trap moisture, we recommend using wood- or mineral-fibre 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	
Vapour diffusion resistance factor (μ)	~ 60
Diffusion-equivalent air layer thickness (s_d)	μ x t (in m)
Vapour permeability (r)	< 30 ng/pa•s•m

CROSS SECTION OF WALL

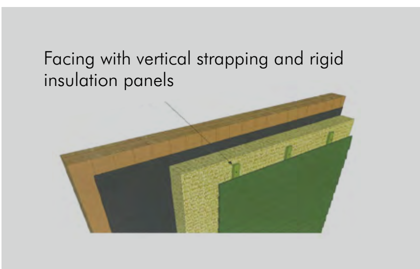


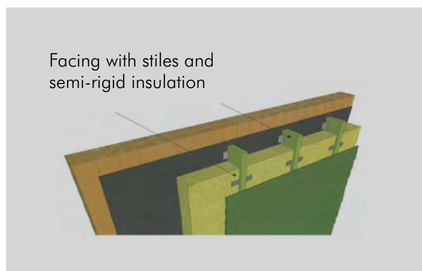
AIR LEAKAGE CONTROL

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

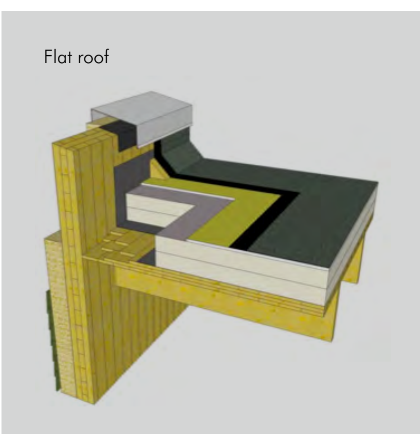
Installing insulation boards on cross-laminated timber panels using vertical strapping is recommended in order to facilitate the installation of cladding and create necessary drainage space. If less rigid insulation boards, such as glass fibre or mineral wool boards, are used, framing members must be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





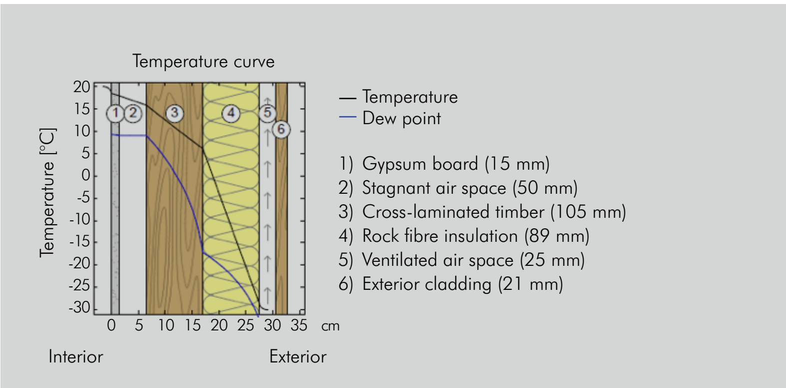
ROOF DETAILS

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	0.65 mm/min
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.

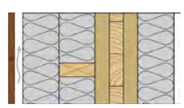
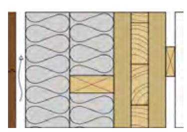
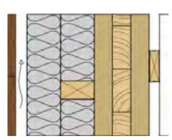
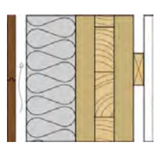
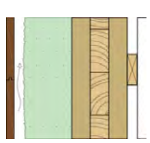
CARBON FOOTPRINT (per m^3)	
Carbon absorbed in forests	765 kg CO_2eq.

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 EXTERIOR WALLS

TYPICAL COMPOSITIONS — EXTERIOR WALLS

EXTERIOR WALL TYPE	No	DESCRIPTION(1)	FRR(2)	RSI(3)	R(4)
	**E1**	- wood furring, 2 rows of 89 mm at 610 mm o.c. - rock fibre insulation, 2 layers of 89 mm - cross-laminated timber 105 mm - wood furring, 89 mm at 610 mm o.c. - rock fibre insulation, 89 mm - 1 layer 15.9 mm Type X gypsum board	1 h	8.0	45
	**E2**	- wood furring, 2 rows of 89 mm at 610 mm o.c. - rock fibre insulation, 2 layers of 89 mm - cross-laminated timber 105 mm	n/a	5.6	32
	E2.1	- wood furring, 2 rows of 89 mm at 610 mm o.c. - rock fibre insulation, 2 layers of 89 mm - cross-laminated timber 105 mm - wood furring, 19 mm at 610 mm o.c. - 1 layer 15.9 mm Type X gypsum board	1 h	5.7	32
	**E3**	- wood furring, 2 rows of 64 mm at 610 mm o.c. - rock fibre insulation, 2 layers of 64 mm - cross-laminated timber 105 mm	n/a	4.3	24
	E3.1	- wood furring, 2 rows of 64 mm at 610 mm o.c. - rock fibre insulation, 2 layers of 64 mm - cross-laminated timber 105 mm - wood furring, 19 mm at 610 mm o.c. - 1 layer 15.9 mm Type X gypsum board	1 h	4.4	25
	**E4**	- wood furring, 89 mm at 610 mm o.c. - rock fibre insulation, 89 mm - cross-laminated timber 105 mm	n/a	3.3	19
	E4.1	- wood furring, 89 mm at 610 mm o.c. - rock fibre insulation, 89 mm - cross-laminated timber 105 mm - wood furring, 19 mm at 610 mm o.c. - 1 layer 15.9 mm Type X gypsum board	1 h	3.4	19
	**E5**	- wood furring, 89 mm at 610 mm o.c. - sprayed foam insulation, 89 mm - cross-laminated timber 105 mm	n/a	4.4	25
	E5.1	- wood furring, 89 mm at 610 mm o.c. - sprayed foam insulation, 89 mm - cross-laminated timber 105 mm - wood furring, 19 mm at 610 mm o.c. - 1 layer 15.9 mm 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. Higher fire resistance ratings may be possible by design.

(3) Total thermal resistance of the wall element (m^2 °C/W); see minimum requirements according to different codes on page 31.

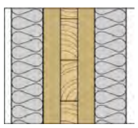
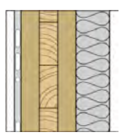
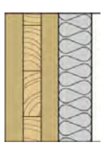
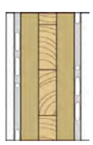
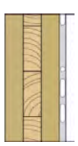
(4) Total thermal resistance of the wall element (R value); to convert the RSI value to R value, divide the RSI value by 0.1761.

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

(6) Based on test results, these compositions are in conformance to the recommendations of the NBC 2010 for air barrier systems by air infiltration and exfiltration measured under a differential pressure difference of 75 Pa.

INTERIOR WALLS

TYPICAL COMPOSITIONS — INTERIOR WALLS

INTERIOR WALL TYPE	No	DESCRIPTION	FRR[1]	STC[2]
	M1	- 1 layer Type X gypsum board - mineral wool, 64 mm - wood studs, 64 mm at 610 mm o.c. - cross-laminated timber 105 mm - wood studs, 64 mm at 610 mm o.c. - mineral wool, 64 mm - 1 layer 15.9 mm Type X gypsum board	1 h	58[3]
	M2	- 1 layer Type X gypsum board - resilient metal channels at 406 mm o.c. - cross-laminated timber 105 mm - air gap, 10 mm (optional) - wood studs, 64 mm at 610 mm o.c. - mineral wool, 64 mm - 1 layer 15.9 mm Type X gypsum board	1 h	53[4]
	M3	- cross-laminated timber 105 mm	30 min.	33[3]
	M3.1	- cross-laminated timber 105 mm - air gap, 10 mm (optional) - wood studs, 64 mm at 610 mm o.c. - mineral wool, 64 mm - 1 layer 15.9 mm Type X gypsum board	30 min.	50[4]
	M4	- 1 layer 15.9 mm Type X gypsum board - resilient metal channels at 406 mm o.c. - cross-laminated timber 105 mm - resilient metal channels at 406 mm o.c. - 1 layer 15.9 mm Type X gypsum board	1 h	37[3]
	M5	- cross-laminated timber 105 mm	30 min.	33[3]
	M5.1	- cross-laminated timber 105 mm - resilient metal channels at 406 mm o.c. - 1 layer 15.9 mm 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. Higher fire resistance ratings may be possible by design.

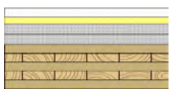
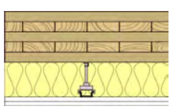
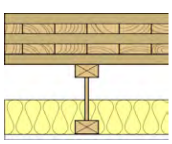
(2) The building code requires that a dwelling unit shall be separated from every other space in a building in which noise may be generated by construction providing a sound transmission class rating not less than 50, measured in accordance with the applicable standards. *(Ref. National Building Code of Canada 2010, Articles 5.9.1.2. and 9.11.2.1)*

(3) Value based on a 105 mm wood panel. *(Ref. CLT Handbook, Chapter 9)*

(4) Value obtained from field test results, adjusted for ITS. *(Ref. Research report, FPInnovations, January 2014)*

FLOORS

TYPICAL COMPOSITIONS — FLOORS

FLOOR TYPE	No	DESCRIPTION	FRR[1]	STC[2]	IIC[3]
	**P1**	- gypsum fibreboard FERMACELL, 25 mm - sub-floor ISOVER EP3, 20 mm - honeycomb acoustic infill (screed), 2x 30 mm - Kraft paper underlayment - cross-laminated timber 175 mm	1.5 h	62	59
	P1.1	+ 1 layer 15.9 mm Type X gypsum board	2 h	> 62	> 59
	**P2**	- carpet or floating flooring, 10 mm - resilient underlayment (rubber mat or textured felt), 3 mm - at least 76 kg/m2 wet topping (concrete, gypcrete, gypsum) - resilient underlayment (10 mm rubber mat, 18 mm textured felt, or 12 mm low density wood fibreboard) - cross-laminated timber 175 mm	1.5 h	> 53[4]	> 55[4]
	P2.1	+ 1 layer 15.9 mm Type X gypsum board	2 h	> 53[4]	> 55[4]
	**P3**	- carpet or floating flooring, 10 mm - resilient underlayment (rubber mat or textured felt), 3 mm - at least 25 kg/m2 dry topping (20 mm Fermacell, cement fibreboard, or Fibrerock) - resilient underlayment (10 mm rubber mat, 18 mm textured felt, or 12 mm low density wood fibreboard) - cross-laminated timber 175 mm	1.5 h	> 48[4]	> 50[4]
	P3.1	+ 1 layer 15.9 mm Type X gypsum board	2 h	> 48[4]	> 50[4]
	**P4**	- bois lamellé-croisé 175 mm	1.5 h	39[5]	27[5]
	P4.1	- cross-laminated timber 175 mm - cross-laminated timber 175 mm - sound insulation clips of 100 mm high - metal hat channels, at min. 406 mm o.c. - sound insulation material, 100 mm - 2 layers 12,7 mm Type X gypsum board	2 h	64	59
	**P5**	- cross-laminated timber 175 mm	1.5 h	39[5]	27[5]
	P5.1	- FERMACELL 2E32 or Permabase and Sonopan - cross-laminated timber 175 mm - 200 mm wood I-joists, 610 mm o.c. - sound insulation material, 89 mm - 1 layer 15.9 mm 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. Higher fire resistance ratings may be possible by design.

(2) The building code requires that a dwelling unit shall be separated from every other space in a building in which noise may be generated by construction providing a sound transmission class rating not less than 50, measured in accordance with the applicable standards. *(Ref. National Building Code of Canada 2005, Articles 5.9.1.2. and 9.11.2.1)*

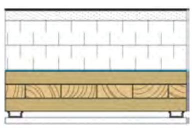
(3) The higher the IIC, the better the attenuation of impact sound, with 50 usually considered the minimum rating for occupant satisfaction in residential buildings.

(4) Value obtained from field test results, adjusted based on FSTC ≈ FIIC + 5 points and STC ≈ FSTC + 3 points. *(Ref. Test report, FPInnovations)*

(5) Values have been adjusted for a 175 mm wood slab. *(Ref. CLT Handbook, Chapter 9)*

ROOFS

TYPICAL COMPOSITIONS — ROOFS

ROOF TYPE	No	DESCRIPTION[1]	FRR[2]	RSI[3]	R[4]
	T1	- membrane and underlayment - fibreboard, 25 mm *(Perlite)* - rigid insulation, 127 mm - 2 ply Vapour barrier - cross-laminated timber 105 mm	n/a	5.8	33
	T1.1	+ resilient metal channels at 406 mm o.c. + 1 layer 15.9 mm 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. Higher fire resistance ratings may be possible by design.

(3) Total thermal resistance of the wall element (m^2 °C/W); see minimum requirements according to different codes below.

(4) Total thermal resistance of the wall element (R value); to convert the RSI value to R value, divide the RSI value by 0.1761.

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

THERMAL RESISTANCES, MINIMUM REQUIREMENTS

BUILDING COMPONENT[1]			EXTERIOR WALL		ROOF OR CEILING	
REFERENCE	ZONE (DEGREE-DAYS UNDER 18 °C)	*Example*	RSI	R	RSI	R
Passive house[3]			8.81	50	8.81	50
Novoclimat[4]			4.31	24	4.31	24
L.R.Q., c. B-1.1[5]	Zone A (≤ 6200)	*Malartic*	4.31	24	7.22	41
	Zone B (> 6200)	*Dolbeau*	5.11	29	9.00	51
NECB 2011[6]	Zone 5 (from 3000 to 3999)	*Toronto*	3.60	20	5.46	31
	Zone 6 (from 4000 to 4999)	*Montreal*	4.05	23	5.46	31
	Zone 7 (from 5000 to 6999)	*Québec*	4.76	27	6.17	35

NOTES:

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

(2) The heating degree-days for a given location can be found in Appendix C of the National Building Code.

(3) Required insulation levels are determined by modeling the building and relevant climate data. In most parts of Canada insulation levels of at least RSI = 8.81 m^2 °C/W (i.e. R-50) are required throughout the building envelope.

(4) For the Novoclimat program, the insulation of above ground walls and type III roofs must meet the minium required RSI = 4.31, and the coverage of thermal bridges as prescribed in sections 1.1.4 and 1.1.3, respectively, of the document *« Exigences techniques pour les immeubles à logements et à condominiums ».*

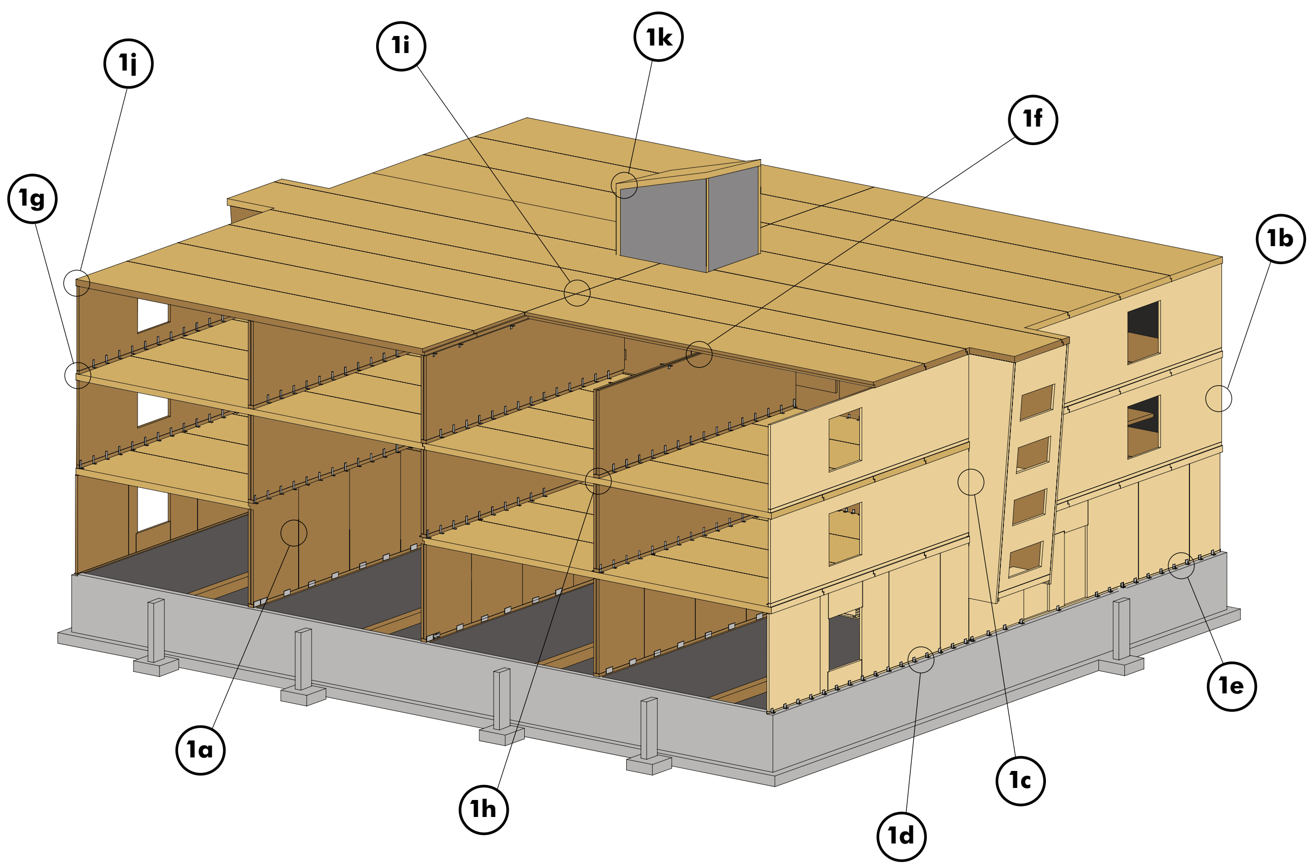
(5) According to the draft law amending the building code to promote energy efficiency (c. B-1.1).

(6) The prescriptive requirements of the NECB, division B, part 3, set a maximum overall thermal transmittance (U-value). These values vary only with the heating degree-day location of the building.

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.

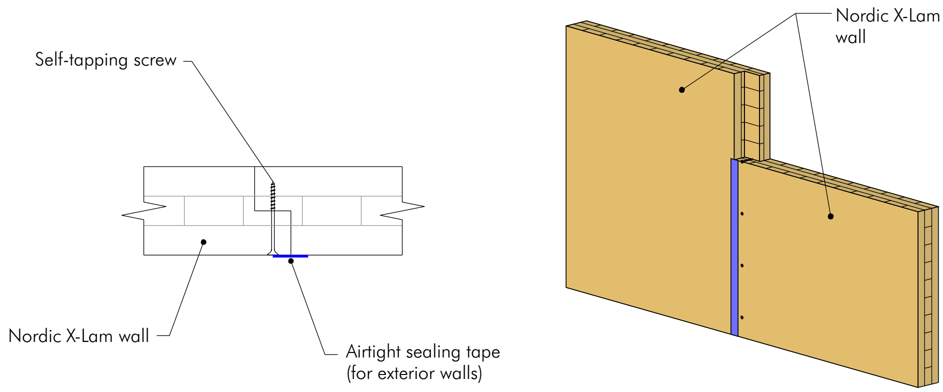
NOTES:

1. The details shown in Figure 1 are intended as guides. The final design shall include considerations for the specified resistances, end and edge distances, spacing between fasteners, dimensional changes, installation requirements, 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.

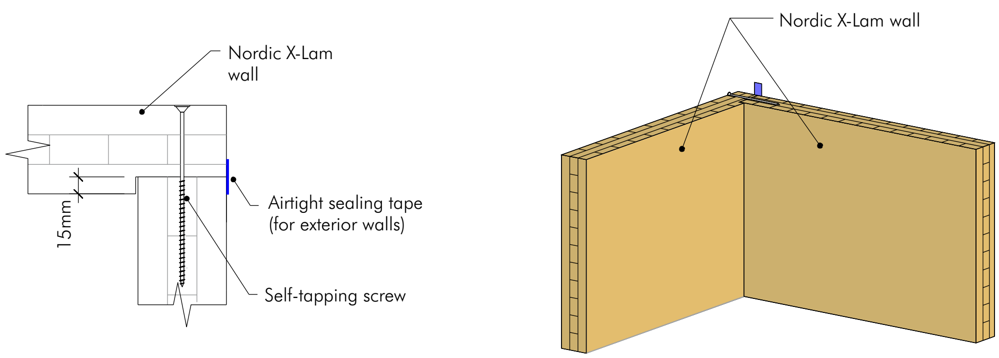
FIGURE 1

TYPICAL CONNECTION DETAILS (continued)

1a WALL JOINT



1b CORNER JOINT



1c CORNER JOINT

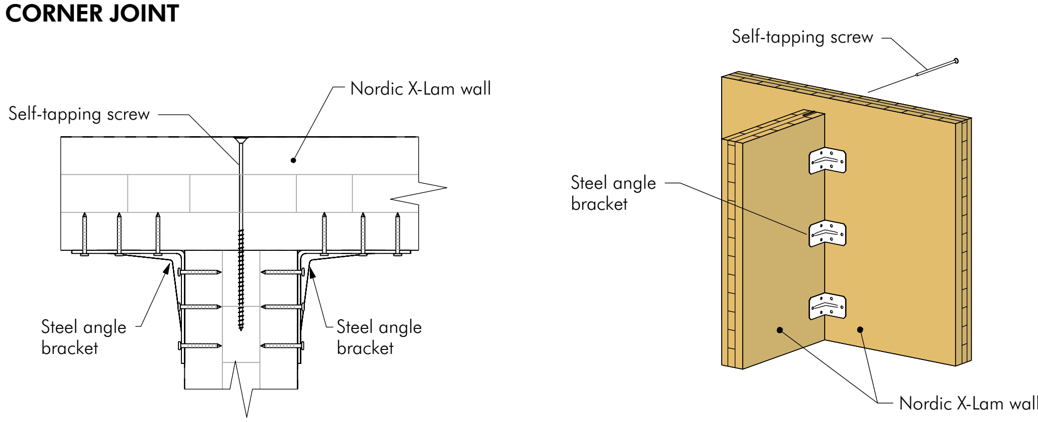
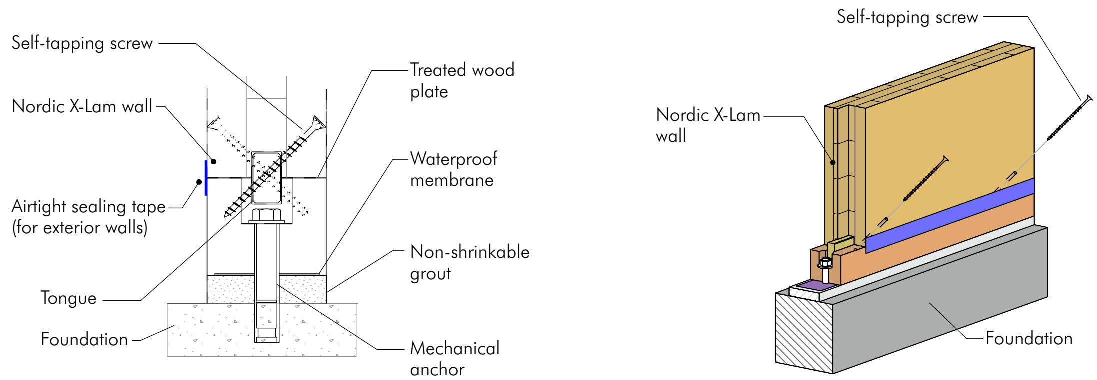


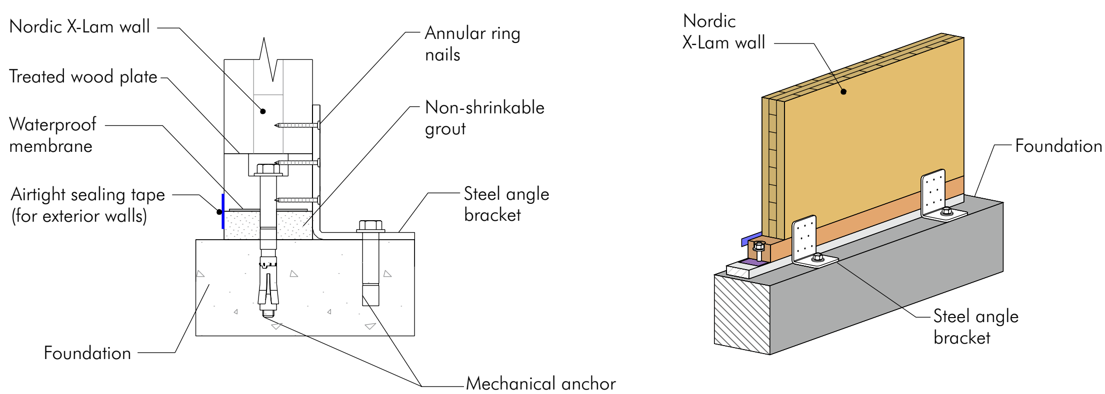
FIGURE 1

TYPICAL CONNECTION DETAILS (continued)

1d WALL/FOUNDATION DETAIL, WITH TONGUE & GROOVE



1e WALL/FOUNDATION DETAIL, WITH STEEL ANGLE BRACKETS



1f FLOOR/WALL CONNECTION

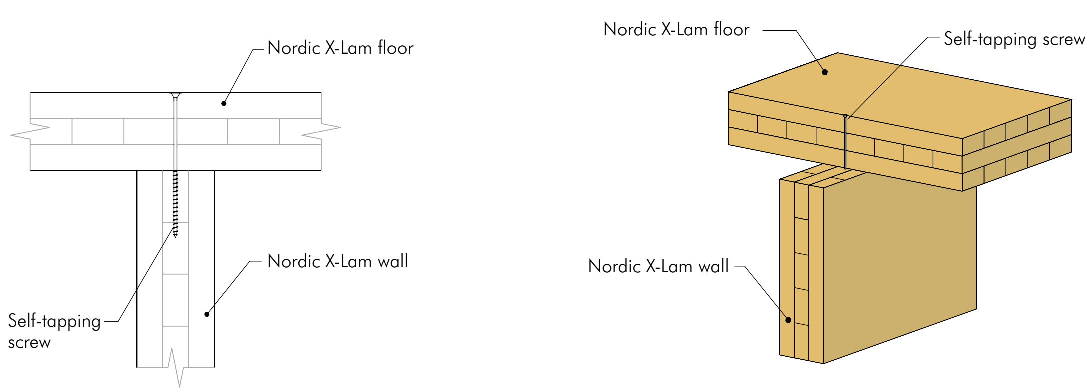
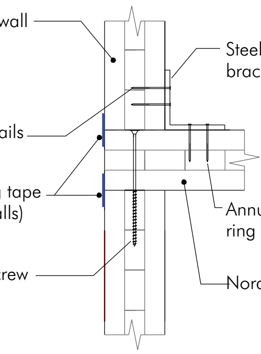
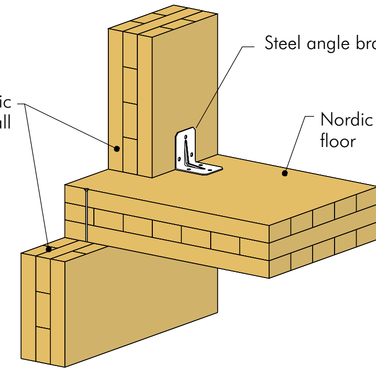


FIGURE 1
TYPICAL CONNECTION DETAILS (continued)

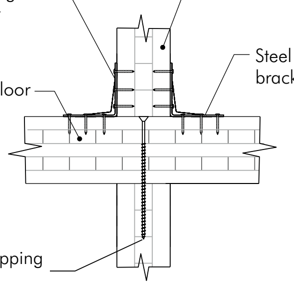
1g EXTERIOR WALL/FLOOR CONNECTION

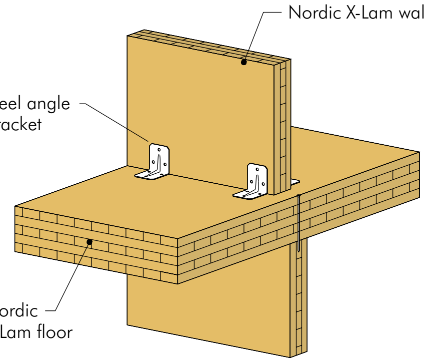




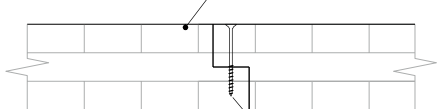
Note: Steel plates installed on the outside can be used instead of steel angle brackets.

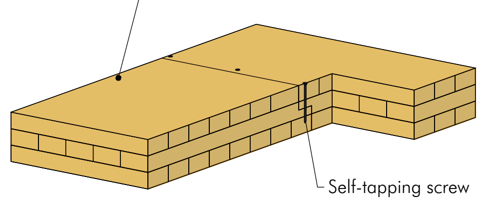
1h INTERIOR WALL/FLOOR CONNECTION





1i FLOOR (OR ROOF) JOINT

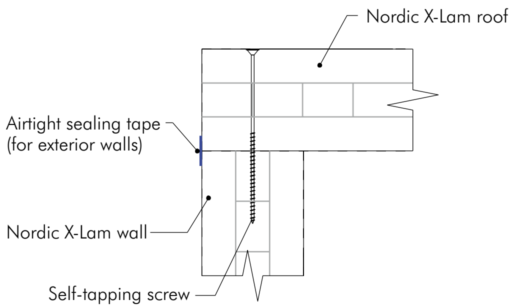


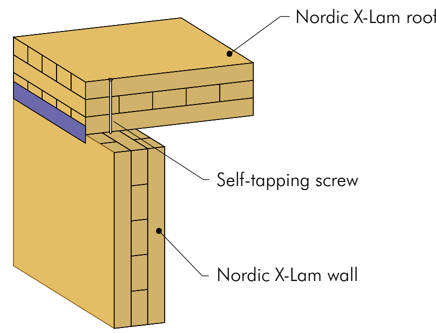


Note: A surface spline joint with plywood may be used instead of a half-lapped joint as shown.

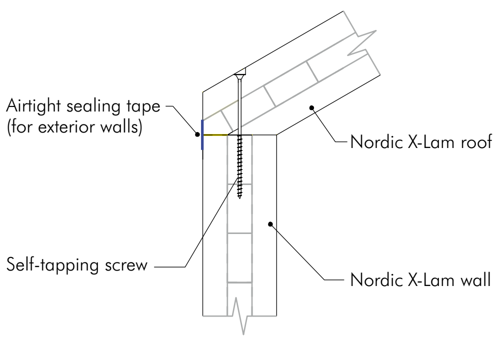
FIGURE 1
TYPICAL CONNECTION DETAILS (continued)

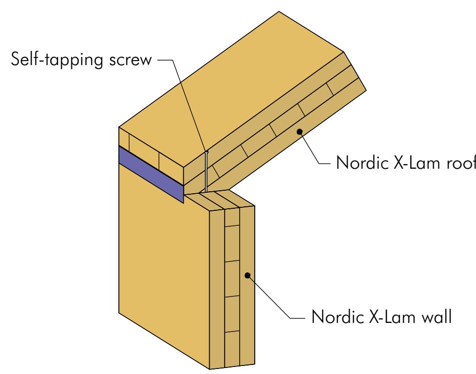
1j ROOF/WALL CONNECTION





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

FACTORED RESISTANCES, SCREWS (kN)

PANEL THICKNESS (mm)	PANEL-TO-PANEL CONNECTIONS				SLAB-TO-WALL CONNECTIONS			
	ASSY 3.0 Ø 6 mm[1]				ASSY 3.0 Ø 8 mm[1]			
	DIAMETER (mm)	LENGTH (mm)	LATERAL[2] (kN)	WITHDR.[3] (kN)	DIAMETER (mm)	LENGTH (mm)	LATERAL[2] (kN)	WITHDR.[3] (kN)
78-3s	6	70	0.34	n/a	8	160	1.26	5.04
105-3s	6	100	0.50	n/a	8	200	1.35	5.04
131-5s	6	120	0.61	n/a	8	240	1.45	6.44
175-5s	6	160	0.71	n/a	8	280	1.42	6.44
220-7s	6	180	0.70	n/a	8	320	1.39	6.44
244-7l	6	240	0.71	n/a	8	340	1.36	6.16
314-9l	6	300	0.71	n/a	8	400	1.29	5.46

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).
2. Factored lateral resistance of one screw, based on a short-term load duration (K_D = 1.15). For normal loading applications, divide the values by 1.15.
3. Factored withdrawal resistance of one screw, based on a short-term load duration (K_D = 1.15).
4. The resistance values are based on the CCMC Evaluation Report 13677-R for SWG ASSY® 3.0 self-tapping wood screws and the CSA O86-09.
5. The minimum spacing, end and edge distances shall be as specified in the CCMC Evaluation Report 13677-R.

FACTORED RESISTANCES, NAILS (kN)

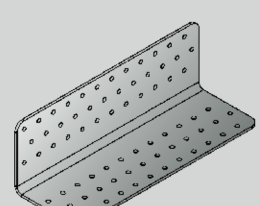
STEEL THICKNESS (mm)	METAL BRACKET CONNECTIONS[1]				STEEL PLATE CONNECTIONS[3]			
	10 NAILS 4-60[2]				NAIL 4-40 OU 6-60[4]			
	DIAMETER (mm)	LENGTH (mm)	LATERAL (kN)	WITHDR. (kN)	DIAMETER (mm)	LENGTH (mm)	LATERAL (kN)	WITHDR. (kN)
2.5	4	60	6.78	2.27	n/a	n/a	n/a	n/a
4.8	n/a	n/a	n/a	n/a	4	40	1.37	0.16
6.4	n/a	n/a	n/a	n/a	6	60	2.78	0.34

NOTES:
1. Simpson Strong-Tie ABR9020 (90 x 90 mm) metal brackets.
2. The factored lateral and withdrawal resistances 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 4.8 mm (3/16") or 6.4 mm (1/4"), grade CSA G40.21, designed according to the applicable standards. The minimum spacing, end and edge distances shall be as specified in CSA O86-09.
4. The factored lateral and withdrawal resistances for 4-40 (diameter of 4 mm and length of 40 mm) or 6-60 (diameter of 6 mm and length of 60 mm) nails, for one nail, are based on CSA O86-09.
5. The factored resistance values are based on a short-term load duration (K_D = 1.15). For normal loading applications, divide the values by 1.15.

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

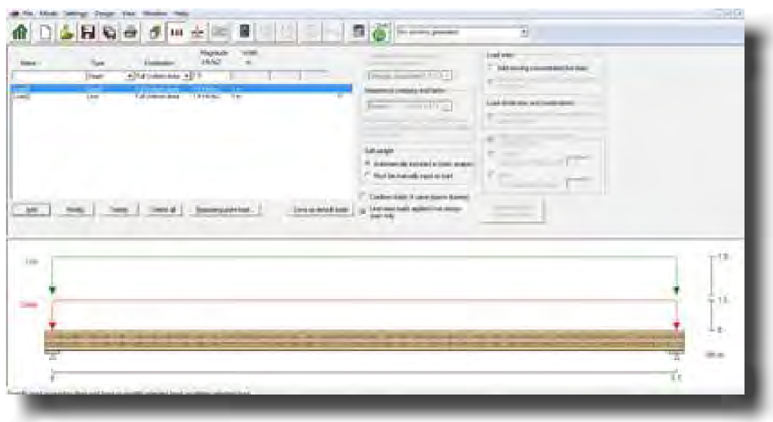
Nordic Sizer is a software program that can be used to design individual members (joists, beams, floor/roof slabs, studs, columns, wall panels) using the full range of Nordic engineered wood products, including **cross-laminated timber.**

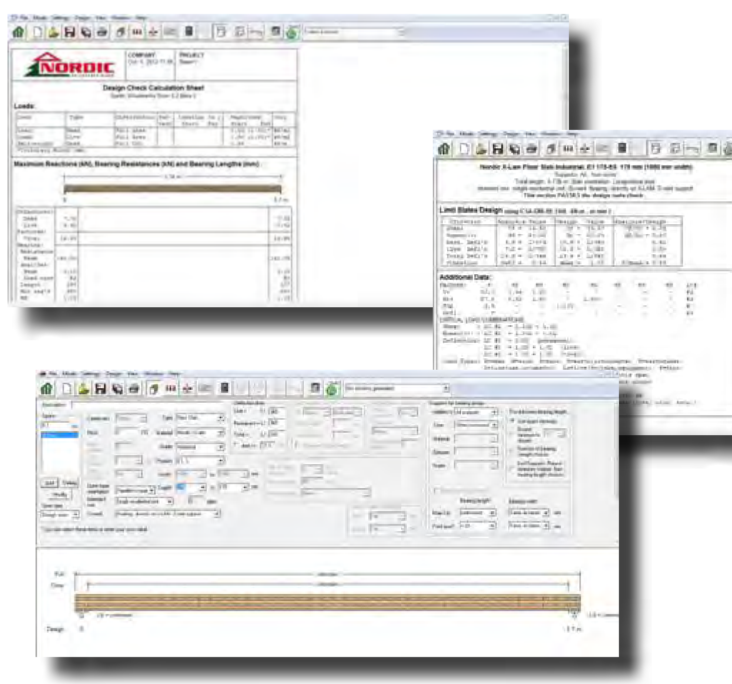
Users can analyze and verify simple or multiple span members for specified dead, live, snow and wind loads, as per **CSA O86-09 or -14,** and automatically patterns loads and checks all load combinations as per NBCC 2010. Joists and beams may be horizontal, sloped or have an oblique angle.

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 NBCC 2010 Appendix D and/or the char rate design methodology.

Nordic Sizer





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-L306C. Nordic X-Lam products are used as structural members and are manufactured in accordance with the in-plant manufacturing standards approved by APA. The adhesives used to manufacture the CLT products are exterior or limited-moisture exposure adhesives meeting the requirements of CSA O112.9 or CSA O112.10, respectively, 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 Canada for New Construction and Major Renovations Standard.

TABLE 1
2009 LEED CANADA 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 800 km of the final manufacturing site. Demonstrate that the final manufacturing site is within 800 km (2,400 km 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 800 km of the final manufacturing site. The mean harvesting distance is 100 km, and the farthest distance 240 km.
- Nordic X-Lam is made of 96% (by weight) of wood fibre; 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

The mark of responsible forestry

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