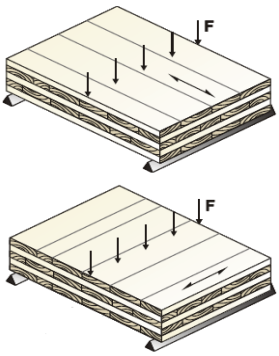
Design Properties, Nordic Cross-Laminated Timber

FACTORED RESISTANCES AND STRENGTHS [1][2][3]

Product	Nordic X-Lam		
Application	Floor and Roof Panels		
Appearance grade	Industrial or Architectural		
Layup Combination	105-3s	175-5s	245-7s
Bending about the longitudinal axis			
Bending moment, $M_{r,0}$ (10^6 N-mm/m)	44,7	102,2	179,8
Shear, $V_{r,0}$ (10^3 N/m)	31,4	52,4	73,3
Compression perp. to grain, F_{cp} (MPa)[4]	5,3	5,3	5,3
Bending rigidity, $EI_{eff,0}$ (10^9 N-mm^2/m)	1 080	4 112	10 135
Shear rigidity, $GA^*_{eff,0}$ (10^3 N/m)	6 081	12 161	18 242
Bending about the transversal axis			
Bending moment, $M_{r,90}$ (10^6 N-mm/m)	1,28	11,1	25,4
Shear, $V_{r,90}$ (10^3 N/m)	31,4	52,4	73,3
Compression perp. to grain, F_{cp} (MPa)[4]	5,3	5,3	5,3
Bending rigidity, $EI_{eff,90}$ (10^9 N-mm^2/m)	31,9	831	3 163
Shear rigidity, $GA^*_{eff,90}$ (10^3 N/m)	7 534	15 067	22 601



[1] The tabulated design values are for dry service conditions and standard term duration of load.
[2] Nordic X-Lam bending panels are symmetrical throughout the depth of the member (balanced layups).
[3] The factored resistance values, M_r and V_r, include the resistance factor, ϕ. The shear rigidity values, GA^*_{eff}, include a shear coefficient form factor, κ, of 1,2.
[4] The compression perpendicular to grain values are based on S-P-F No. 3/Stud lumber (f_{cp} = 5,3 MPa).
[5] The compression parallel to grain values shall be based on S-P-F MSR 1950F_b (f_c = 19,3 MPa) or S-P-F No. 3/Stud (f_c = 9,0 MPa) lumber for longitudinal and transversal lamellas, respectively. These values shall be adjusted by the slenderness factor, K_C, as defined in CSA O86-09 Standard Clause 5.5.6.
[6] The specified resistances are based on FPInnovations proposed design method, simplified Kreuzinger. Otherwise, design of cross-laminated timber members shall be in accordance to CSA O86-09 Standard. *(Ref.: CLT Handbook, Chapter 3 - Structural design of cross-laminated timber elements, FPInnovations, February 2011)*
[7] Beams and lintels may be designed based on the simplified method proposed in the CLT Handbook, assuming a composite action between effective longitudinal boards. The design shall be based on the properties of the longitudinal layers in tension and the effective cross-section. *(Ref. CLT Hanbook, Chapter 3, Section 2.5.1)*
[8] The specific gravity for dowel-type fastener design is 0,42. Member weight shall be based on density of 5.5 kN/m^3.

* Nordic X-Lam products have been tested by FPInnovations and are certified by APA.

Design

DESIGN

Floor and roof panels	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.
Diaphragms	It is suggested that buildings with CLT diaphragms be designed using the International Building Code analogy (IBC 2009).
Cantilevered elements	For cantilevered CLT slabs, it is suggested that the length, ℓ, be taken as twice the cantilever length, ℓ_e.
Wall panels	Only the layers parallel to the axial load shall be taken into account. For more details, refer to CLT Hanbook Chapter 3, Section 2.4.
Lintel design	CLT elements under axial in-plane loads acting as deep beams or lintels may be designed using the strengths shown below and an effective cross-section based on the layers perpendicular to the load. *(Ref.: CLT Hanbook, Chapter 3, Section 2.5)*
DOL 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 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.
Vibration design	The proposed vibration criteria is applicable for: 1. bare floors with finishes and partitions, without heavy topping; 2. vibrations induced by normal walking; 3. well supported floors; 4. well connected CLT panels; 5. incluson of the self weight of CLT panels only; not live load.
Fire resistant design	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.

MATERIAL CHARACTERISTICS

Material characteristics

Product	Lamellas	
Orientation	Longitudinal	Transversal
Species identification	S-P-F	S-P-F
Stress class	1950Fb 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 (psi)	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	9 000
Modulus of shear, G_0 (MPa)	731,25	562,5
Rolling shear, G_s (MPa)	73,125	56,25

CLT panel layups

Product	Composition (L = longitudinal, T = transversal)	Number of plies	Thickness (mm)
105-3s	35L - 35T - 35L	3	105
175-5s	35L - 35T - 35L - 35T - 35L	5	175
245-7s	35L - 35T - 35L - 35T - 35L - 35T - 35L	7	245