

## Design Properties, Nordic X-Lam

### Characteristics

Nordic X-Lam cross-laminated timber (CLT) is certified according to E1 CLT stress grade, using 1950F<sub>b</sub>-1.7E Spruce-Pine-Fir (S-P-F) MSR lumber in longitudinal layers and No. 3/Stud S-P-F lumber in the transverse layers. Nordic X-Lam products are certified by APA (Product Report PR-L306C) per the ANSI/APA PRG 320 Standard.

### Material Design Properties

CLT stress grade	E1	
	Layers	
Orientation	Longitudinal	Transversal
Species combination	S-P-F	S-P-F
Stress class	1950F <sub>b</sub> 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 (MPa)	11 700	9 000
Shear modulus, G (MPa)	731	563
Rolling shear modulus, $G_s$ (MPa)	73.1	56.3

Note:

1. Appearance grades as defined in ANSI/APA PRG 320 do not affect the structural performance of CLT panels.

### Panel Layups

Product <sup>(a)</sup>	Layup combination <sup>(b)</sup>	Number of plies	Thickness		Weight		
			(mm)	(in.)	(kg/m <sup>2</sup> )	(kN/m <sup>2</sup> )	(psf)
89-3s	35L - 19T - 35L	3	89	3 1/2	45.8	0.45	9.38
105-3s	35L - 35T - 35L	3	105	4 1/8	54.0	0.53	11.1
140-4s	35L - 35T - 35T - 35L	4	140	5 1/2	71.9	0.71	14.7
143-5s	35L - 19T - 35L - 19T - 35L	5	143	5 5/8	73.6	0.72	15.1
175-5s	35L - 35T - 35L - 35T - 35L	5	175	6 7/8	89.9	0.88	18.4
197-7s	35L - 19T - 35L - 19T - 35L - 19T - 35L	7	197	7 3/4	101	0.99	20.8
213-7l	35L - 35L - 19T - 35L - 19T - 35L - 35L	7	213	8 3/8	110	1.07	22.4
244-7s	35L - 35T - 35L - 35T - 35L - 35T - 35L	7	244	9 5/8	126	1.24	25.8
244-7l	35L - 35L - 35T - 35L - 35T - 35L - 35L	7	244	9 5/8	126	1.24	25.8
267-9l	35L - 35L - 19T - 35L - 19T - 35L - 19T - 35L - 35L	9	267	10 1/2	137	1.35	28.1

a) The product 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).

b) L = longitudinal, T = transversal, 35 = 1.375" = 34.925 mm, 19 = 0.75" = 19.05 mm

## Design Properties, Nordic X-Lam (continued)

### Design Properties – Floor/Roof Slabs

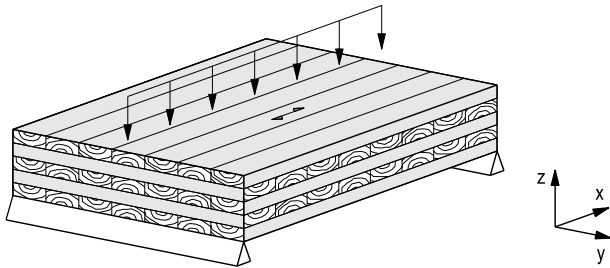
CLT stress grade	E1 (L 1950F <sub>b</sub> MSR and T No. 3/Stud)									
Layup combination	89-3s	105-3s	140-4s	143-5s	175-5s	197-7s	213-7l	244-7s	244-7l	267-9l
<i>Bending about the major strength axis (y-y)</i>										
Bending moment resistance, $M_{r,y}$ ( $10^6$ N-mm/m) <sup>(a)</sup>	28	38	62	65	87	115	157	154	199	238
Shear resistance, $V_{r,zy}$ ( $10^3$ N/m) <sup>(b)</sup>	26	30	37	38	42	49	62	53	68	74
Bending stiffness, $(EI)_{\text{eff},y}$ ( $10^9$ N-mm <sup>2</sup> /m)	678	1 081	2 334	2 514	4 140	6 152	9 056	10 240	13 194	17 211
Shear rigidity, $(GA)_{\text{eff},y}$ ( $10^6$ N/m)	7.5	7.3	8.5	15	15	23	36	22	31	43
<i>Bending about the minor strength axis (x-x)</i>										
Bending moment resistance, $M_{r,x}$ ( $10^6$ N-mm/m) <sup>(a)</sup>	0.38	1.3	5.1	5.0	11	11	5.0	25	11	11
Shear resistance, $V_{r,zx}$ ( $10^3$ N/m) <sup>(b)</sup>	5.7	10	21	20	30	25	20	41	30	25
Bending stiffness, $(EI)_{\text{eff},x}$ ( $10^9$ N-mm <sup>2</sup> /m)	5.2	32	256	260	831	1 015	260	3 163	831	1 015
Shear rigidity, $(GA)_{\text{eff},x}$ ( $10^6$ N/m)	5.7	9.0	18	11	18	17	21	27	28	27

a) The factored bending moment resistance values,  $M_r$ , include the resistance factor,  $\phi$ , and the adjustment factor  $K_{tb}$ , as defined in the Update No. 1 of CSA O86-14.

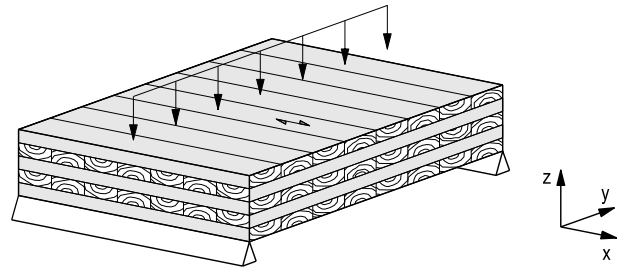
b) The factored shear resistance values,  $V_r$ , include the resistance factor,  $\phi$ .

#### Notes:

1. The tabulated design values are for dry service conditions and standard term duration of load.
2. The compressive resistance perpendicular to grain values shall be based on S-P-F No. 3/Stud lumber ( $f_{cp} = 5.3$  MPa).
3. The specific gravity for dowel-type fastener design,  $G$ , is 0.42.
4. Member weight shall be based on density of 515 kg/m<sup>3</sup> (5.1 kN/m<sup>3</sup>).
5. Design of CLT members shall be in accordance with the Update No. 1 of CSA O86-14.



Bending about the major strength axis (y-y)



Bending about the minor strength axis (x-x)

## Design Properties, Nordic X-Lam (continued)

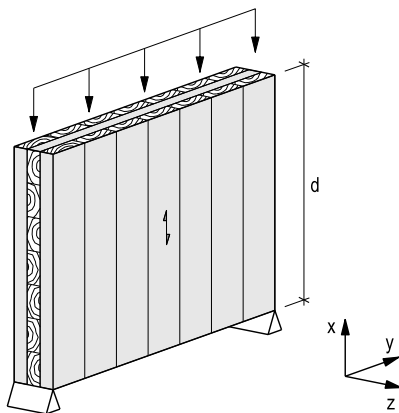
### Design Properties – Walls, Lintels, and Diaphragms

CLT stress grade	E1 (L 1950F <sub>b</sub> MSR and T No. 3/Stud)									
Layup combination	89-3s	105-3s	140-4s	143-5s	175-5s	197-7s	213-7l	244-7s	244-7l	267-9l
<i>Loading parallel to outermost layers</i>										
<i>Compression parallel to x-axis</i>										
Compressive resistance, $P_{r,x}$ ( $10^3$ N/m) <sup>(a)</sup>	1 078	1 078	1 078	1 618	1 618	2 157	2 696	2 157	2 696	3 235
Effective area, $A_{eff,x}$ ( $10^3$ mm <sup>2</sup> /m)	70	70	70	105	105	140	175	140	175	210
Radius of gyration, $r_{eff,x}$ (mm/m)	29	36	53	45	58	61	67	79	80	84
<i>Bending about z-z axis</i>										
Effective width, $b_{eff,xz}$ (mm) <sup>(b)</sup>	19	35	70	38	70	57	38	105	70	57
Specified in-plane shear strength, $f_{v,xz}$ (MPa) <sup>(c)</sup>	0.93	1.35	1.35	1.35	1.60	1.35	1.60	1.60	1.60	1.35
Shear rigidity, $G_v t_{v,xz}$ ( $10^6$ N/m) <sup>(d)</sup>	22	26	35	36	44	49	53	61	61	67
<i>Loading perpendicular to outermost layers</i>										
<i>Compression parallel to y-axis</i>										
Compressive resistance, $P_{r,y}$ ( $10^3$ N/m) <sup>(a)</sup>	137	251	503	274	503	411	274	754	503	411
Effective area, $A_{eff,y}$ ( $10^3$ mm <sup>2</sup> /m)	19	35	70	38	70	57	38	105	70	57
Radius of gyration, $r_{eff,y}$ (mm/m)	5.5	10	20	28	36	44	28	58	36	44
<i>Bending about z-z axis</i>										
Effective width, $b_{eff,yz}$ (mm) <sup>(b)</sup>	70	70	70	105	105	140	175	140	175	210
Specified in-plane shear strength, $f_{v,yz}$ (MPa) <sup>(c)</sup>	1.67	1.67	1.67	1.92	1.92	1.92	1.92	1.92	1.92	1.92
Shear rigidity, $G_v t_{v,yz}$ ( $10^6$ N/m) <sup>(d)</sup>	22	26	35	36	44	49	53	61	61	67

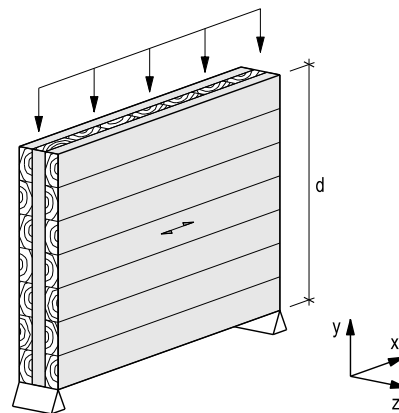
- a) The factored compressive resistance parallel to grain values,  $P_r$ , include the resistance factor,  $\phi$ . Furthermore, these values shall be adjusted by the size and slenderness factors,  $K_{zc}$  and  $K_c$ , respectively, as defined in the Update No. 1 of CSA O86-14.
- b) The factored bending moment resistance,  $M_r$ , and the effective bending stiffness,  $(EI)_{eff}$ , values shall be based on the effective width and depth of the panel,  $b_{eff}$  and  $d$  (see table above and figures below), respectively, and Clause 7.5.6.5 of the Update No. 1 of CSA O86-14. Calculations shall be based on S-P-F No. 3/Stud lumber ( $f_b = 7.0$  MPa,  $E = 9\,000$  MPa) for loading parallel to outermost layer, or on S-P-F MSR 1950F<sub>b</sub> lumber ( $f_b = 28.2$  MPa,  $E = 11\,700$  MPa) for loading perpendicular to outermost layer.
- c) The factored shear resistance values,  $V_r$ , shall be based on Clause 7.5.7.2 of CSA O86-14, taking into account the gross cross-sectional area of the panel and using the specified in-plane shear strength,  $f_v$ .
- d)  $G_v = 250$  MPa based on product performance testing. The shear rigidity,  $(GA)_{eff}$ , shall be calculated by multiplying  $G_v t_v$  by the member depth,  $d$  (see figures below).

#### Notes:

- The tabulated design values are for dry service conditions and standard term duration of load.
- The compressive resistance perpendicular to grain values shall be based on S-P-F No. 3/Stud lumber ( $f_{cp} = 5.3$  MPa).
- The specific gravity for dowel-type fastener design,  $G$ , is 0.42.
- Member weight shall be based on density of 515 kg/m<sup>3</sup> (5.1 kN/m<sup>3</sup>).
- Design of CLT members shall be in accordance with the Update No. 1 of CSA O86-14.



Loading parallel to outermost layers



Loading perpendicular to outermost layers