NORDIC STRUCTURES

Design Properties, Nordic X-Lam

Characteristics

Nordic X-Lam cross-laminated timber (CLT) is certified according to E1 CLT stress grade, using 1950f-1.7E Spruce-Pine-Fir (S-P-F) MSR lumber in longitudinal layers and No. 3 S-P-F lumber in the transverse layers. Nordic X-Lam products are certified by APA (Product Report PR-L306) 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 MSR	No. 3
Bending at extreme fiber, F_b (psi)	1,950	500
Shear parallel to grain, F_v (psi)	135	135
Rolling shear, F_s (psi)	45	45
Compression parallel to grain, F_c (psi)	1,800	650
Compression perpendicular to grain, F_{cp} (psi)	425	425
Tension parallel to grain, F_t (psi)	1,375	250
Modulus of elasticity, E (psi)	1,700,000	1,200,000
Shear modulus, G (psi)	106,250	75,000
Rolling shear modulus, G_s (psi)	10,625	7,500

Note:

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

Panel Layups

Product [a]	Layup combination [b]	Number of plies	Thickness (mm)	Thickness (in.)	Weight (kg/m²)	Weight (kN/m²)	Weight (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 - 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
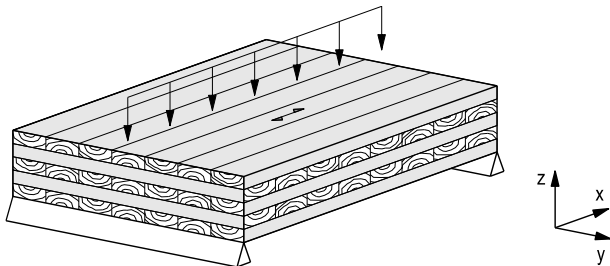
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Design Properties, Nordic X-Lam (continued)

Design Properties – Floor/Roof Slabs

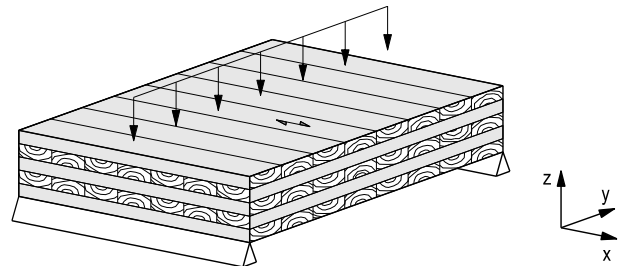| CLT stress grade	E1 (L 1950f MSR and T No. 3)									
Layup combination	89-3s	105-3s	140-4s	143-5s	175-5s	197-7s	213-7l	244-7s	244-7l	267-9l
Bending about the major strength direction (y-y)										
Bending moment capacity, M_0 (lbf-ft/ft) [a]	3,350	4,525	7,325	7,725	10,400	13,725	18,700	18,375	23,700	28,325
Shear capacity, V_0 (lbf/ft)	1,250	1,430	1,740	1,790	1,970	2,310	2,900	2,490	3,200	3,525
Bending stiffness, $EI_{eff,0}$ (10^6 lbf-in.^{2}/ft)	72	115	248	267	440	654	963	1,089	1,404	1,831
Shear rigidity, $GA_{eff,0}$ (10^6 lbf/ft)	0.48	0.46	0.54	0.96	0.92	1.4	2.3	1.4	2.0	2.7
Bending about the minor strength direction (x-x)										
Bending moment capacity, M_{90} (lbf-ft/ft) [a]	45	160	630	615	1,370	1,380	615	3,125	1,370	1,380
Shear capacity, V_{90} (lbf/ft)	270	495	990	920	1,430	1,190	920	1,960	1,430	1,190
Bending stiffness, $EI_{eff,90}$ (10^6 lbf-in.^{2}/ft)	0.51	3.1	25	25	81	99	25	309	81	99
Shear rigidity, $GA_{eff,90}$ (10^6 lbf/ft)	0.39	0.61	1.2	0.78	1.2	1.2	1.4	1.8	1.9	1.8

a) The bending moment capacity values in the major strength direction, M_0, include the adjustment factor of 0.85 as defined in ANSI/APA PRG 320.

Notes:

1. The tabulated design values are for dry conditions of use and normal duration of loading.
2. The compressive capacity perpendicular to grain values shall be based on S-P-F No. 3 lumber (f_{cp} = 425 psi).
3. The specific gravity for dowel-type fastener design is 0.41.
4. Member weight shall be based on density of 32 pcf.
5. Design of CLT members shall be in accordance with the 2015 NDS.

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

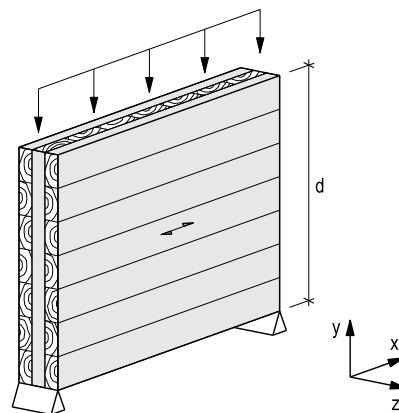| CLT stress grade	E1 (L 1950f MSR and T No. 3)									
Layup combination	89-3s	105-3s	140-4s	143-5s	175-5s	197-7s	213-7l	244-7s	244-7l	267-9l
Loading parallel to outermost layers										
Compression parallel to x-axis										
Compressive capacity, P_0 (10^3 lbf/ft) [a]	59	59	59	89	89	119	149	119	149	178
Effective area, A_{eff} (in.^{2}/ft)	33	33	33	50	50	66	83	66	83	99
Radius of gyration, r_{eff} (in./ft)	1.1	1.4	2.1	1.8	2.3	2.4	2.6	3.1	3.2	3.3
Bending about z-z										
Effective width, b_{eff} (in.) [b]	0.75	1.38	2.75	1.50	2.75	2.25	1.50	4.13	2.75	2.25
In-plane shear capacity, $F_{v,0}$ (psi) [c]	75	105	105	105	125	105	125	125	125	105
Shear rigidity, $G_v t_{v,0}$ (10^6 lbf/ft) [d]	1.52	1.79	2.39	2.44	2.99	3.37	3.64	4.18	4.18	4.56
Loading perpendicular to outermost layers										
Compression parallel to y-axis										
Compressive capacity, P_{90} (10^3 lbf/ft) [a]	5.8	11.0	21.0	12.0	21.0	18.0	12.0	32.0	21.0	18.0
Effective area, A_{eff} (in.^{2}/ft)	9	17	33	18	33	27	18	50	33	27
Radius of gyration, r_{eff} (in./ft)	0.2	0.4	0.8	1.1	1.4	1.7	1.1	2.3	1.4	1.7
Bending about z-z										
Effective width, b_{eff} (in.) [b]	2.75	2.75	2.75	4.13	4.13	5.50	6.88	5.50	6.88	8.25
In-plane shear capacity, $F_{v,90}$ (psi) [c]	130	130	130	150	150	150	150	150	150	150
Shear rigidity, $G_v t_{v,90}$ (10^6 lbf/ft) [d]	1.52	1.79	2.39	2.44	2.99	3.37	3.64	4.18	4.18	4.56

a) The compressive capacity parallel to grain values, P_0 and $P_{90,}$ shall be ajusted by the column stability factor, C_P, as defined in 2015 NDS.

b) The bending moment capacity, M, 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 Section 5 of the 2015 NDS. Calculations shall be based on S-P-F No. 3 lumber (F_b = 500 psi, E = 1,200,000 psi) for loading parallel to outermost layer, or on S-P-F 1950f MSR lumber (F_b = 1,950 psi, E = 1,700,000 psi) for loading perpendicular to outermost layer.

c) The shear capacity values, V, shall be based on Section 5 of the 2015 NDS, taking into account the gross cross-sectional area of the panel and using the in-plane shear capacity, F_v.

d) G_v = 36,200 psi based on product performance testing. The shear rigidity, $(GA)_{eff}$, shall be calculated by multiplying $G_v t_v$ by the member depth, d, in feet (see figures below).

Notes:

1. The tabulated design values are for dry conditions of use and normal duration of loading.

2. The compressive capacity perpendicular to grain values shall be based on S-P-F No. 3 lumber (f_{cp} = 425 psi).

3. The specific gravity for dowel-type fastener design is 0.41.

4. Member weight shall be based on density of 32 pcf.

5. Design of CLT members shall be in accordance with the 2015 NDS.
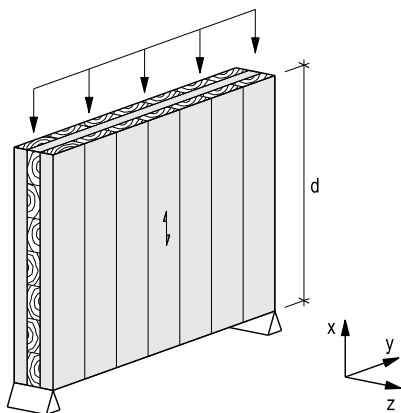
Loading parallel to outermost layers

Loading perpendicular to outermost layers