

Nordic X-Lam – Design Properties

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 shall be used in dry service conditions and 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-1.7E 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:

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

Panel Layouts

Product ^(a)	Layout combination ^(b)	Number of layers	Thickness		Weight		
			(mm)	(in.)	(kg/m ²)	(kN/m ²)	(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
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 layout 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

Floor/Roof Slabs – Design Properties

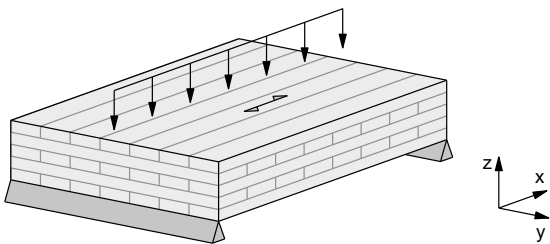
Floor/Roof Slabs – Design Properties

CLT stress grade	E1 (L = S-P-F 1950f MSR and T = S-P-F No. 3)								
Layup combination	89-3s	105-3s	143-5s	175-5s	197-7s	213-7l	244-7s	244-7l	267-9l
Bending in the major strength direction (y-y)									
Bending moment capacity, M_0 (lb-ft/ft) ^(a)	3,350	4,525	7,725	10,400	13,725	18,700	18,375	23,700	28,325
Shear capacity, V_0 (lb/ft)	1,260	1,490	2,030	2,480	2,800	3,025	3,475	3,475	3,775
Bending stiffness, $EI_{eff,0}$ (10^6 lb-ft ² /ft)	72	115	267	440	654	963	1,089	1,404	1,831
Shear rigidity, $GA_{eff,0}$ (10^6 lb/ft)	0.48	0.46	0.96	0.92	1.4	1.6	1.4	1.4	2.0
Bending in the minor strength direction (x-x)									
Bending moment capacity, M_{90} (lb-ft/ft) ^(a)	45	160	615	1,370	1,410	615	3,150	1,370	1,410
Shear capacity, V_{90} (lb/ft)	270	495	1,040	1,490	1,800	1,040	2,480	1,490	1,800
Bending stiffness, $EI_{eff,90}$ (10^6 lb-ft ² /ft)	0.51	3.1	26	81	101	26	313	81	101
Shear rigidity, $GA_{eff,90}$ (10^6 lb/ft)	0.39	0.61	0.78	1.2	1.2	0.93	1.8	1.3	1.3

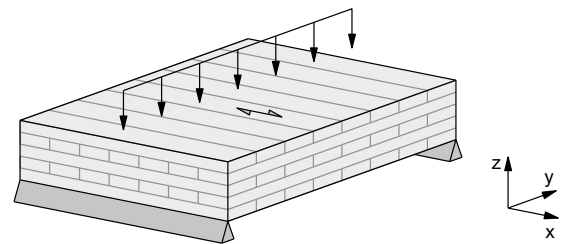
a) The bending moment capacity values in the major strength direction, M_0 , include the adjustment factor of 0.85 as defined in ANSI/APA PRG 320.

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 in the major strength direction (y-y)



Bending in the minor strength direction (x-x)

Walls – Design Properties

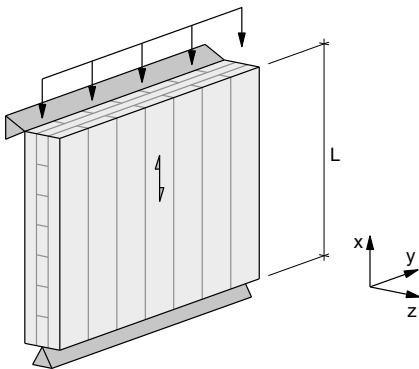
Walls – Design Properties

CLT stress grade	E1 (L = S-P-F 1950f MSR and T = S-P-F No. 3)								
Layup combination	89-3s	105-3s	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	89	89	119	149	119	149	178
Effective area, $A_{\text{eff},0}$ ($\text{in.}^2/\text{ft}$)	33	33	50	50	66	83	66	83	99
Effective moment of inertia, $I_{\text{eff},0}$ ($\text{in.}^4/\text{ft}$)	42	68	157	257	383	566	634	824	1,075
Radius of gyration, $r_{\text{eff},0}$ ($\text{in.}/\text{ft}$) ^(b)	1.1	1.4	1.8	2.3	2.4	2.6	3.1	3.2	3.3
Bending in the major strength direction (y-y)									
Bending moment capacity, M_0 (lbf-ft/ft) ^(c)	3,350	4,525	7,725	10,400	13,725	18,700	18,375	23,700	28,325
Shear capacity, V_0 (lbf/ft)	1,260	1,490	2,030	2,480	2,800	3,025	3,475	3,475	3,775
Bending stiffness, $EI_{\text{eff},0}$ (10^6 lbf-in. ² /ft)	72	115	267	440	654	963	1,089	1,404	1,831
Shear rigidity, $GA_{\text{eff},0}$ (10^6 lbf/ft)	0.48	0.46	0.96	0.92	1.4	1.6	1.4	1.4	2.0
Loading perpendicular to outermost layers									
Compression parallel to y-axis									
Compressive capacity, P_{90} (10^3 lbf/ft) ^(a)	5.9	11	12	21	18	12	32	21	18
Effective area, $A_{\text{eff},90}$ ($\text{in.}^2/\text{ft}$)	9.0	17	18	33	27	18	50	33	27
Effective moment of inertia, $I_{\text{eff},90}$ ($\text{in.}^4/\text{ft}$)	0.42	2.6	21	68	83	21	257	68	83
Radius of gyration, $r_{\text{eff},90}$ ($\text{in.}/\text{ft}$) ^(b)	0.22	0.40	1.1	1.4	1.7	1.1	2.3	1.4	1.7
Bending in the minor strength axis (x-x)									
Bending moment capacity, M_{90} (lbf-ft/ft) ^(c)	45	160	615	1,370	1,410	615	3,150	1,370	1,410
Shear capacity, V_{90} (lbf/ft)	270	495	1,040	1,490	1,800	1,040	2,480	1,490	1,800
Bending stiffness, $EI_{\text{eff},90}$ (10^6 lbf-in. ² /ft)	0.51	3.1	26	81	101	26	313	81	101
Shear rigidity, $GA_{\text{eff},90}$ (10^6 lbf/ft)	0.39	0.61	0.78	1.2	1.2	0.93	1.8	1.3	1.3

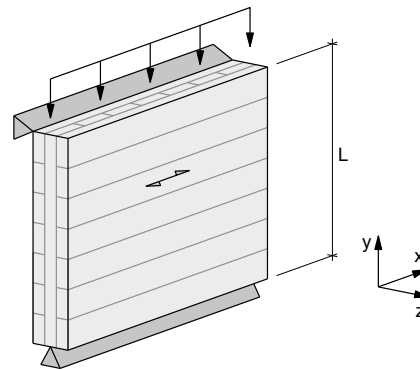
- a) The compressive capacity parallel to grain values, P_0 and P_{90} , shall be adjusted by the column stability factor, C_p , as defined in the 2015 NDS. The effective bending stiffness, $(EI)_{\text{eff}}$, values shall be based on S-P-F 1950f MSR lumber ($E = 1,700,000$ psi) and on $I_{\text{eff},0}$ for loading parallel to outermost layers, or on S-P-F No. 3 lumber ($E = 1,200,000$ psi) and on $I_{\text{eff},90}$ for loading perpendicular to outermost layers. The critical buckling design value, F_{cE} , shall be calculated as follows: $F_{cE} = \pi^2 (EI)_{\text{app-min}} / (\ell_e)^2 A_{\text{eff}}$.
- b) As per 2015 NDS 3.7.1.4, the slenderness ratio for walls, $\ell_e / (\sqrt{12} r_{\text{eff}})$, shall not exceed 50, except that during construction $\ell_e / (\sqrt{12} r_{\text{eff}})$ shall not exceed 75.
- c) 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:

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



Loading parallel to outermost layers



Loading perpendicular to outermost layers

Shear Walls, Lintels, and Diaphragms – Design Properties

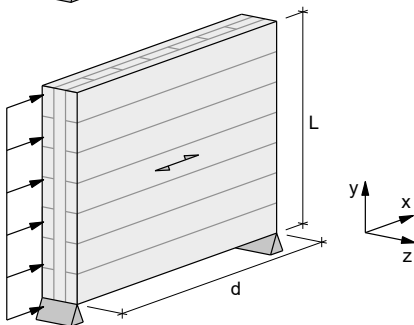
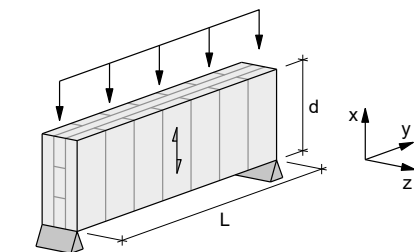
Shear Walls, Lintels, and Diaphragms – Design Properties

CLT stress grade	E1 (L = S-P-F 1950f MSR and T = S-P-F No. 3)								
Layup combination	89-3s	105-3s	143-5s	175-5s	197-7s	213-7l	244-7s	244-7l	267-9l
Loading parallel to outermost layers									
Edgewise bending (z-z)									
Effective width for bending, $b_{\text{eff},90}$ (in.) ^(a)	0.75	1.38	1.50	2.75	2.25	1.50	4.13	2.75	2.25
Shear capacity, $F_{v,90}$ (psi) ^(b)	190	190	215	215	215	215	215	215	215
Shear rigidity, $G_v t_{v,90}$ (10^6 lbf/ft) ^(c)	1.52	1.79	2.44	2.99	3.37	3.64	4.18	4.18	4.56
Loading perpendicular to outermost layers									
Edgewise bending (z-z)									
Effective width for bending, $b_{\text{eff},0}$ (in.) ^(a)	2.75	2.75	4.13	4.13	5.50	6.88	5.50	6.88	8.25
Shear capacity, $F_{v,0}$ (psi) ^(b)	155	155	185	185	155	185	185	185	155
Shear rigidity, $G_v t_{v,0}$ (10^6 lbf/ft) ^(c)	1.52	1.79	2.44	2.99	3.37	3.64	4.18	4.18	4.56

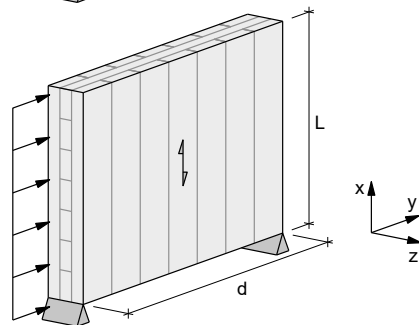
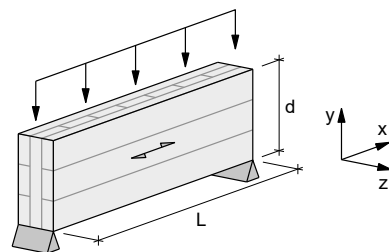
- a) The bending moment capacity, M , and the effective bending stiffness, $(EI)_{\text{eff}}$, values shall be based on the effective width and depth of the panel, b_{eff} and d (see table above and figures below), respectively, and Section 5 of the 2015 NDS. Calculations shall be based on S-P-F No. 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.
- b) 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 .
- c) $G_v = 36,200$ psi based on product performance testing. The shear rigidity, $(GA)_{\text{eff}}$, 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