Supplier	CLT Layup
Timberlink	NX7/220

Design Methodologies

Design Method	Loading Code	Load Combination
AS1720.1	AS1170/AS1720	Default Load Combination

Loading Data

G_{SDL} (kN)	Q (kN)	Condition
1.00 kN	3.00 kN	Two Span Unequal Point Load

Loading Conditions

Calculation Method	Span 1	Span 2
Shear Analogy	4.00 (m)	3.00 (m)

Point Load Data

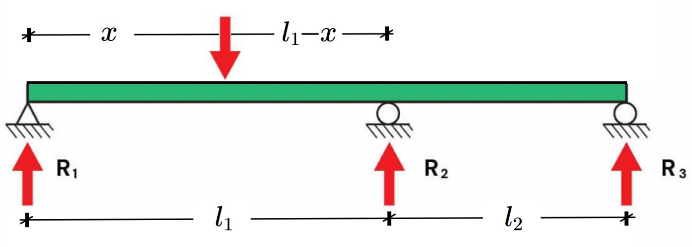
x	b_y	l_y	y	p_x	p_y
0.50 (m)	2.00 (m)	4.50 (m)	0.80 (m)	300 (m)	300 (m)

Design Data AS1720.1

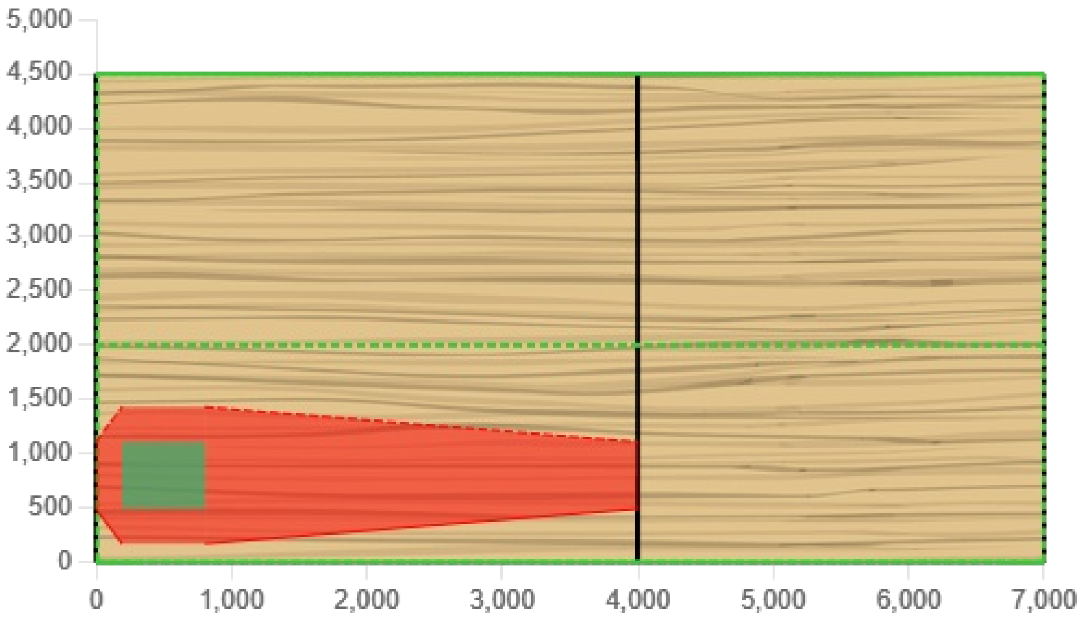
ψ_s	ψ_l	ψ_c	ϕ	w_c	
0.70	0.40	0.40	0.85	0.00 (mm)	
k_4	k_6	k_9	k_{12}	j_2	Deflection Ratio
1.00	1.00	1.00	1.00	2.00	300.00

Outputs Summary

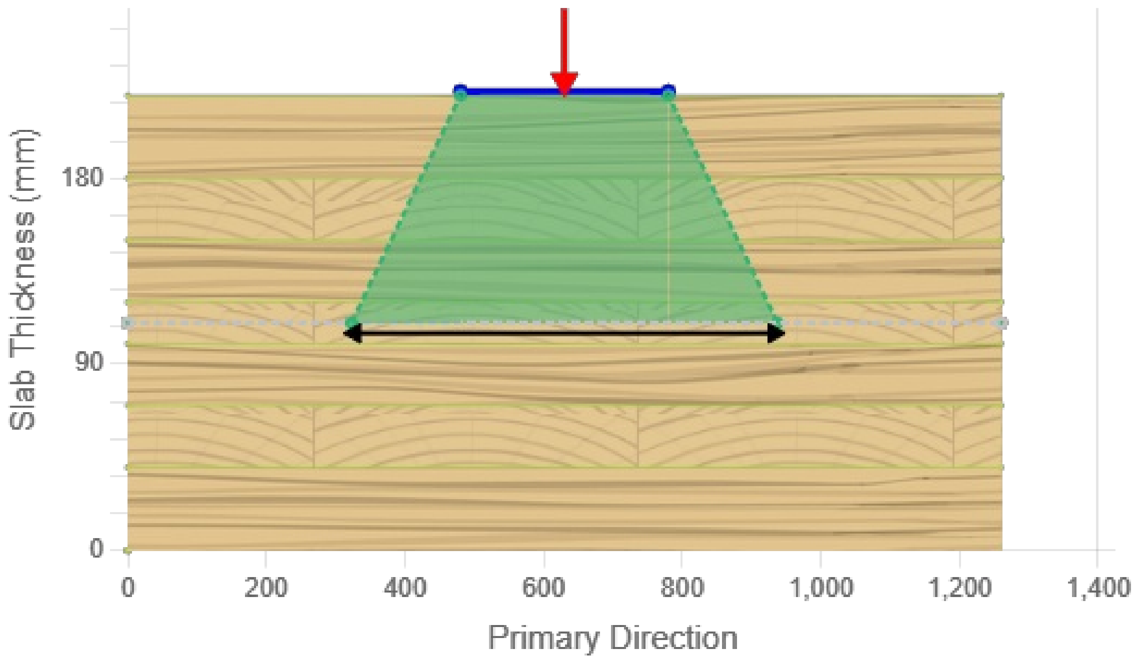
Deflection	Ambient Shear	Ambient Bending
OK	OK	OK
5.5%	4.8%	2.6%



Plotting the panel dimensions



Plotting layup dimensions



Panel Properties (Primary Direction)

t		Grade	E (MPa)	G (MPa)	f'_b (MPa)	f'_s (MPa)	f'_r (MPa)	ρ (kg/m3)
t_1	40	MGP10	10000	670	17	3.8	1.2	500
t_2	30	MGP10	333.3333333	45	17	3.8	1.2	500
t_3	30	MGP10	10000	670	17	3.8	1.2	500
t_4	20	MGP10	333.3333333	45	17	3.8	1.2	500
t_5	30	MGP10	10000	670	17	3.8	1.2	500
t_6	30	MGP10	333.3333333	45	17	3.8	1.2	500
t_7	40	MGP10	10000	670	17	3.8	1.2	500

Calculate Stiffness Via The Shear Analogy Method

$$EI_{eff} = \sum_{i=1}^{n} E_1 b_i \frac{h_i^3}{12} + \sum_{i=1}^{n} E_1 b_i h_i^2$$

FP Innovations 2019 S 3.5.1

Effective Flexural Stiffness: XX-direction

[-]	$b_{eff}\, t_i^3/12$ (mm^4)	$b_{eff}\, t_i\, h_i^2$ (mm^4)	$E_{i,XX}$ (MPa)	$E_i I_i$ (Nmm^2)
t_1	5.33e+6	3.24e+8	10000	3.29e+12
t_2	2.25e+6	9.07e+7	333.3333333	3.10e+10
t_3	2.25e+6	1.87e+7	10000	2.10e+11
t_4	6.67e+5	4.04e-24	333.3333333	2.22e+8
t_5	2.25e+6	1.88e+7	10000	2.10e+11
t_6	2.25e+6	9.08e+7	333.3333333	3.10e+10
t_7	5.33e+6	3.24e+8	10000	3.29e+12

Bending Stiffness Properties of CLT		EI_{eff}
EI_{eff} (Nmm^2) X-X	Bending Stiffness X-X direction	7.07e+12
EI_{eff} (Nmm^2) Y-Y	Bending Stiffness Y-Y direction	2.10e+12

a (mm)	180

$$GA_{eff} = \frac{a^2}{\left[\left(\frac{h_1}{2G_1 b}\right)+\left(\sum_{i=2}^{n-1}\frac{h_i}{G_i b_i}\right)+\left(\frac{h_n}{2G_n b}\right)\right]}$$

FP Innovations 2019 S 3.5.1

[-]	Layers (i/o)	$G_{i,XX}$ (MPa)	$t_i/(2Gb_{eff})$ (mm2/N)	$t_i/(Gb_{eff})$ (mm2/N)
t_1	o	6.70e+2	2.99e-5	0.00e+0
t_2	i	4.50e+1	0.00e+0	6.67e-4
t_3	i	6.70e+2	0.00e+0	4.48e-5
t_4	i	4.50e+1	0.00e+0	4.44e-4
t_5	i	6.70e+2	0.00e+0	4.48e-5
t_6	i	4.50e+1	0.00e+0	6.67e-4
t_7	o	6.70e+2	2.99e-5	0.00e+0

Shear Stiffness Properties of CLT		
GA_{eff_xx}	1.68e+7	Nmm^2
GA_{eff_yy}	1.38e+7	Nmm^2

$$EI_{app} = \frac{EI_{eff}}{1+\frac{K_s EI_{eff}}{GA_{eff}L^2}}$$

FP Innovations 2019 S 3.9

K_s	11.5	Two Span Unequal Point Load
L_{eff} (mm)	4.00e+3	Span length

Apparent Bending Stiffness Properties of CLT		
EI_{app_XX} (Nmm^2)	Apparent Stiffness : X-X direction	5.43e+12
EI_{app_YY} (Nmm^2)	Apparent Stiffness : Y-Y direction	1.89e+12

Stiffness Properties of CLT		XX_Direction	YY_Direction
EI_{app} (Nmm^2)	Serviceability stiffness derived from the Shear Analogy method	5.43e+12	1.89e+12
EI_{eff} (Nmm^2)	Strength stiffness derived from the Shear Analogy method	7.07e+12	2.10e+12

$$Z_{eff} = \frac{EI_{eff}}{E_1} \times \frac{1}{Max(\gamma_c; t_p - \gamma_c)}$$

Outer $lamella_{x\text{-}x}$	T1	
Outer $lamella_{y\text{-}y}$	T2	
$E1_{x\text{-}x}$ (N/mm2)	10000	the outer most longtiudnal lamella stiffness (primary direction)
$E1_{y\text{-}y}$ (N/mm2)	10000	the outer most longtiudnal lamella stiffness (secondary direction)

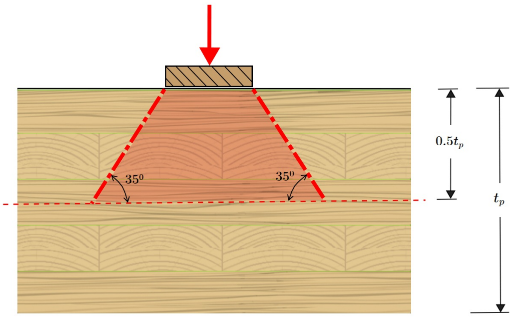
Section Modulus Properties of CLT		
Z_{eff_XX} (mm^3)	Section modulus: XX_direction	6.43e+6
Z_{eff_YY} (mm^3)	Section modulus: YY_direction	1.91e+6

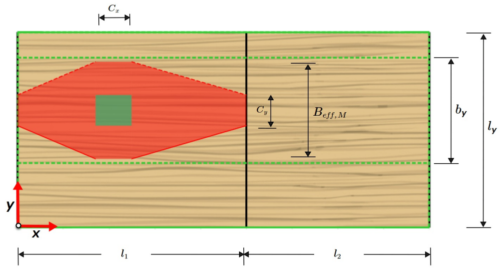
Statical Moment_EQ : XX-direction

[-]	Location	$E_{i,XX}$ (MPa)	$Q_{i,top}$ (Nmm)	$Q_{i,bottom}$ (Nmm^3)	$E_iQ_{i,top}$ (Nmm^3)	$E_iQ_{i,bottom}$ (Nmm)
t_1	above yc	10000	3.60e+6	0.00e+0	3.60e+10	0.00e+0
t_2	above yc	333.3333333	1.65e+6	0.00e+0	5.50e+8	0.00e+0
t_3	above yc	10000	7.50e+5	0.00e+0	7.50e+9	0.00e+0
t_4	mid	333.3333333	5.00e+4	5.00e+4	1.67e+7	1.67e+7
t_5	below yc	10000	0.00e+0	7.50e+5	0.00e+0	7.50e+9
t_6	below yc	333.3333333	0.00e+0	1.65e+6	0.00e+0	5.50e+8
t_7	below yc	10000	0.00e+0	3.60e+6	0.00e+0	3.60e+10

	t (mm)	a (mm)	E (Mpa)	EQ (Nmm)
Mid t upper	10	5	333.3333333	1.67e+7
Mid t lower	-10	-5	333.3333333	-1.67e+7

	Max + (Nmm)	Max - (Nmm)	Abs Max (Nmm)
EQ_R	4.40e+10	-4.40e+10	4.40e+10
EQ_L	4.41e+10	-4.40e+10	4.40e+10





c_x and c_y Calculation

Θ_x (°)	35
Θ_y (°)	35
p_x (mm)	300
p_y (mm)	300
c_x (mm)	614.2
c_y (mm)	614.2

Effective width calculation: Shear Force

$$b_{V,ef} = 1.25c_y$$

ProHolz Volumne 2 Eq.4.37

$b_{V,ef}$ (mm)	768

Effective width calculation: Bending Moment

$$b_{M,ef} = c_y + 2.0x(1 - \frac{x}{l_x})k_{ortho} \leq b_{M,max}$$

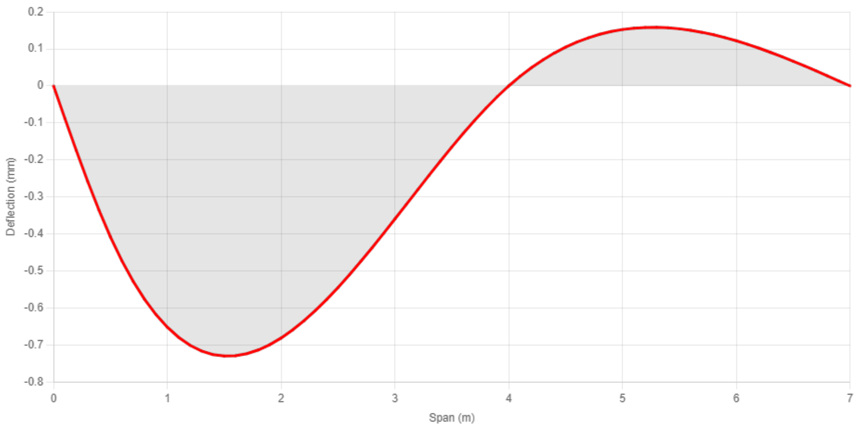
ProHolz Volumne 2 Eq.4.29

$$b_{M,max} = [0.65l_y; b_y]$$

ProHolz Volumne 2 Eq.4.30

$EI_{x,net}$ (Nmm^2)	7.07e+12
$EI_{y,net}$ (Nmm^2)	2.10e+12
k_{ortho}	1
x (mm)	500
$b_{M,max}$ (mm)	2000
$b_{M,ef}$ (mm)	1260
y_{edge} (mm)	800
$b_{M,ef\ upper}$ (mm)	630
$b_{M,ef\ near\ edge}$ (mm)	630

Deflection



Case	Two Span Unequal Point Load

G (kN)	1.00
Q (kN)	3.0
EI_{app} (Nmm^2)	5.43e+12
j_2	2.0
ψ_l	0.4
ψ_s	0.7
L (mm)	4000.0

$w_{long} = (G + \psi_l Q)\, j_2 + (\psi_s - \psi_l)\, Q$ $\quad w_{short} = (G + \psi_s Q)$

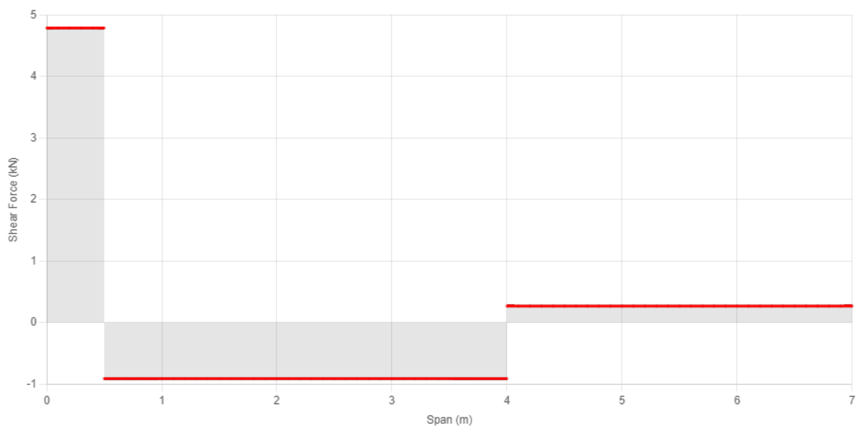
	w (kN/m)	Max Deflection (mm)	Limit (mm)	
$w_{short\ term}$	3.1	0.4		
$w_{long\ term}$	5.3	0.7	13.33	5%
w_c		0.00		5%

Loading

Load Combination	1.35G	1.20G + 0.60Q	1.20G + 1.50Q	1.20G + 0.40Q + 1.00W
w (kN)	1.35	3.00	5.70	2.40

Shear Force

Loading Combination : 1.20G + 1.50Q

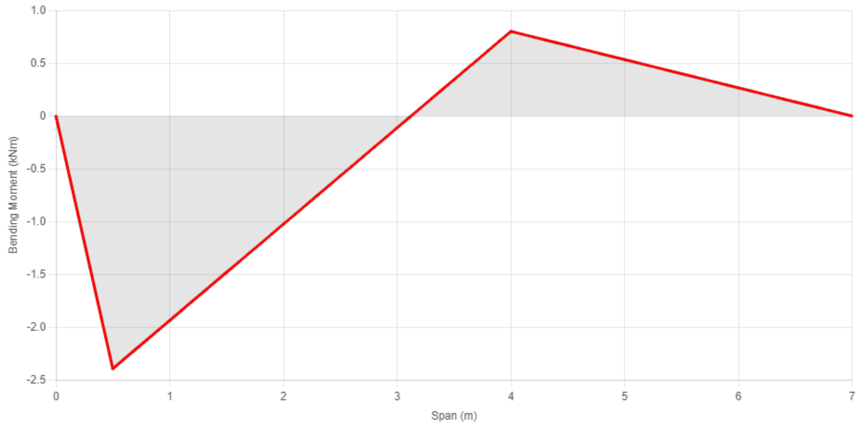


$b_{V,ef}$ (m)	0.77

	Ambient	Ambient	Ambient	Ambient
Load Combination	1.35G	1.20G + 0.60Q	1.20G + 1.50Q	1.20G + 0.40Q + 1.00W
V_{max} (kN)	1.13	2.52	4.79	2.02
$V_{max} / b_{V,ef}$ (kN/m)	1.48	3.28	6.24	2.63

Bendig Moment

$b_{M,ef}$ (m)	1.26



	Ambient	Ambient	Ambient	Ambient
Load Combination	1.35G	1.20G + 0.60Q	1.20G + 1.50Q	1.20G + 0.40Q + 1.00W
M^*_{max+} (kNm)	0.19	0.42	0.80	0.34
M^*_{max-} (kNm)	-0.57	-1.26	-2.39	-1.01
$M^*_{max+} / b_{M,ef}$ (kNm)	0.15	0.33	0.64	0.27
$M^*_{max-} / b_{M,ef}$ (kNm)	-0.45	-1.00	-1.90	-0.80

Bending Design

$$M_d = \phi k_1 k_4 k_6 k_9 k_{12} f_b' Z_{eff}$$

AS1720.1 CL3.2.1

ϕ	k4	k6	k9	k12
0.85	1	1	1	1

$Z_{eff,x}$ (mm^3)	6.43e+6
f'_b (MPa)	17

Load Combination	1.35G	1.20G + 0.60Q	1.20G + 1.50Q	1.20G + 0.40Q + 1.00W	
k_1	0.57	0.57	0.80	1.00	
M_{d+} (kNm)	52.93	52.93	74.29	92.86	
$M^*_+ / b_{M,ef}$ (kNm)	0.15	0.33	0.64	0.27	
Ratio	*0%*	*1%*	*1%*	*0%*	1%
M_{d-} (kNm)	52.93	52.93	74.29	92.86	
$M^*_- / b_{M,ef}$ (kNm)	0.45	1.00	1.90	0.80	
Ratio	*1%*	*2%*	*3%*	*1%*	3%

Shear Design

Calculate Rolling Shear Failure

$$\phi V_r = \frac{\phi k_1 k_4 k_6 f_r' EI_{eff} b_{eff}}{(EQ_r)}$$

AS1720.1 CL3.2.5
CLT Handbook First Edition 2.3.1.3

f'_b (MPa)	1.20

	Max +	Max -	Abs Max
EQ_R (mm^3)	4.40e+10	-4.40e+10	4.40e+10

Load Combination	1.35G	1.20G + 0.60Q	1.20G + 1.50Q	1.20G + 0.40Q + 1.00W	
k_1	0.57	0.57	0.80	1.00	
ϕV_r (kN)	93.30	93.30	130.95	163.68	
$V^*_{max} / b_{V,ef}$ (kN/m)	1.48	3.28	6.24	2.63	
Ratio	*2%*	*4%*	*5%*	*2%*	5%

Calculate Longitudinal Shear Failure

$$\phi V_L = \frac{\phi k_1 k_4 k_6 f_r' EI_{eff} b_{eff}}{(EQ_L)}$$

	Max +	Max -	Abs Max
EQ_L (mm^3)	4.41e+10	-4.41e+10	4.41e+10
f'_s (MPa)	3.80		

Calculate EQ at critical point for longitudinal shear

Load Combination	1.35G	1.20G + 0.60Q	1.20G + 1.50Q	1.20G + 0.40Q + 1.00W	
k_1	0.57	0.57	0.80	1.00	
ϕVL (kN)	295.34	295.34	414.51	518.14	
$V^*_{max} / b_{V,ef}$ (kN/m)	1.48	3.28	6.24	2.63	
Ratio	*1%*	*1%*	*2%*	*1%*	2%