Supplier	CLT Layup	FRL	Glue Line Maintained?	Side Exposed
Xlam Dolomiti	CL7/217	120 (mins)	Yes	Underside

Design Methodologies

Design Method	Loading Code	Load Combinations
Eurocode 5	Eurocode 1	Default Load Combination

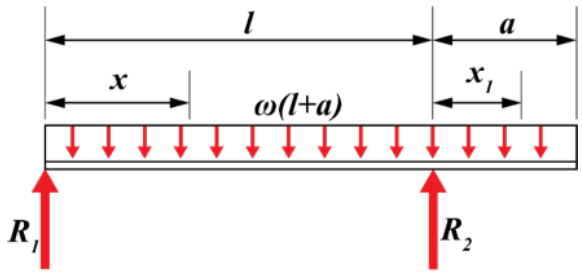
Char Data

Phase 1 - Initially Unprotected	Phase 3 - Post Protected (mm/min)	Phase 4 - Consolidated (mm/min)
Fast Char	Fast Char	Slow Char
0.65 (mm/min)	1.40 (mm/min)	0.65 (mm/min)

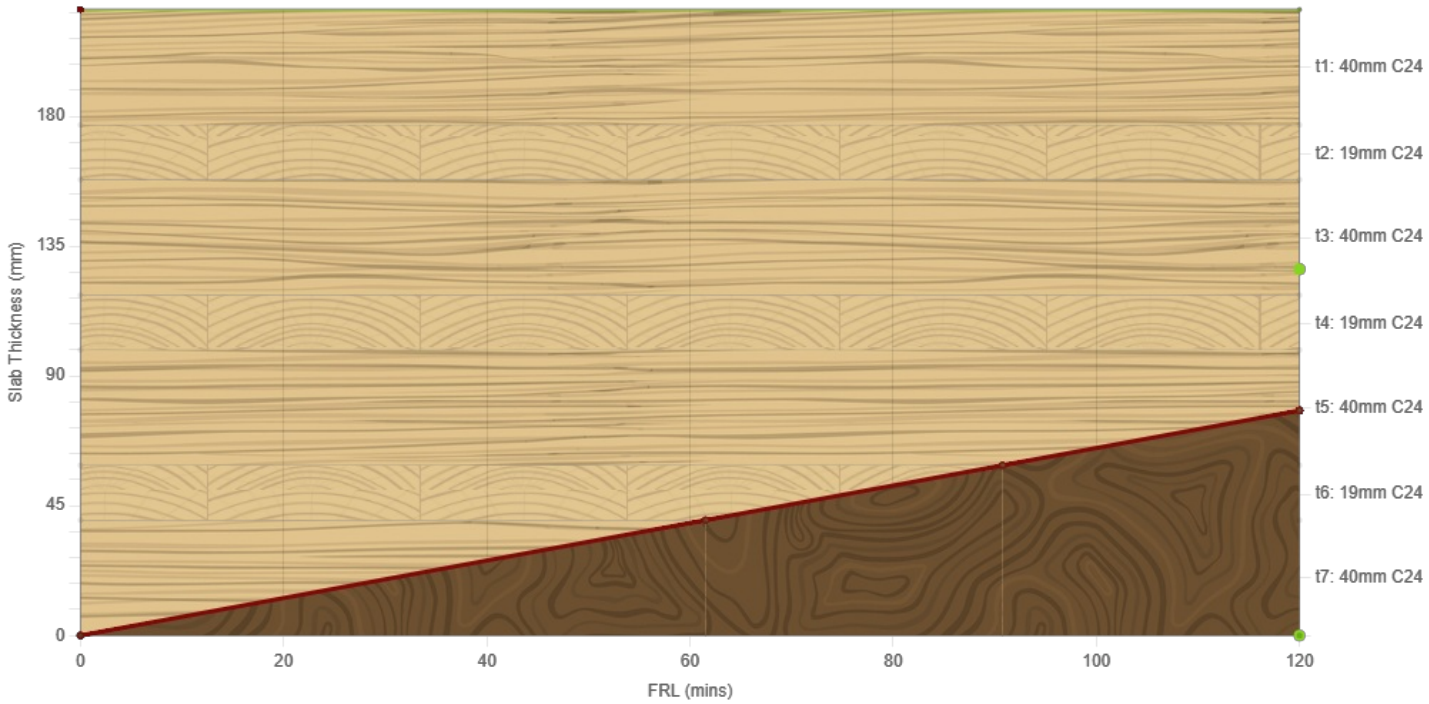
B_{eff}	Q (kN)	G_{SDL} (kN)	Condition	Span
1 (mm)	2 kN	2 kN	Two Span Unequal	5.0 (m)

Outputs Summary

Fire Shear	Fire Bending
OK	OK
10.1%	18.6%



Char Model



Zero Strength Layer

External Lamella Properties		Underside	Topside
Scenario	ZSL scenario (as per 7.2.3 EC5)	Tension side for first layer/Bare	Tension side for other layers/Bare
ZSL (mm)	Zero strength layer removed below char	12	7

Original Section (mm)		1. Charred Section (mm)	2. ZSL Removed (mm)	3. Design Section (mm)	Grade	E (MPa)	f'_b (MPa)	f'_r (MPa)
t_1	40	40	0	40	C24	11,000	24	1.3
t_2	19	19	0	19	C24	366.7	24	1.3
t_3	40	40	0	40	C24	11,000	24	1.3
t_4	19	19	0	19	C24	366.7	24	1.3
t_5	40	21	12	9	C24	11,000	24	1.3
t_6	19	0	12	0	C24	366.7	24	1.3
t_7	40	0	12	0	C24	11,000	24	1.3

Calculate Stiffness Via The Extended Gamma Method

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

Equation System Matrix: XX-direction

Matrix V			Matrix G	Matrix S
1.54e+5	8.42e+4	0.00e+0	0.95	2.28e+5
-1.44e+5	-1.74e+5	2.52e+5	0.97	-5.98e+4
0.00e+0	8.42e+4	-2.56e+5	0.97	-1.68e+5

Matrix V * Matrix G = Matrix S

Effective Flexural Stiffness: XX-direction

[-]	$E_{i,xx}$ (MPa)	a_i (label)	a_i (mm)	$b_{eff}\, t_i^3/12$ (mm^4)	$b_{eff}\, t_i\, a_i^2$ (mm^4)	γ_i (label)	γ_i (-)	$E_i I_{i\ effy}$ (Nmm^2)
t_1	11000	a_1	37.19	5.33e+6	5.53e+7	γ_1	0.95	6.38e+11
t_2	0	-	7.69	0.00e+0	0.00e+0	-	0.00	0.00e+0
t_3	11000	a_2	-21.81	5.33e+6	1.90e+7	γ_2	0.97	2.61e+11
t_4	0	-	-51.31	0.00e+0	0.00e+0	-	0.00	0.00e+0
t_5	11000	a_3	-65.31	6.07e+4	3.84e+7	γ_3	0.97	4.12e+11
t_6	0	-	0.00	0.00e+0	0.00e+0	-	0.00	0.00e+0
t_7	0	a_4	0.00	0.00e+0	0.00e+0	γ_4	0.00	0.00e+0

Bending Stiffness Properties of CLT		EI_{effy}
EI_{effy} (Nmm^2) X-X	Bending Stiffness X-X direction	1.31e+12
EI_{effy} (Nmm^2) Y-Y	Bending Stiffness Y-Y direction	3.64e+11

Stiffness Properties of CLT		XX_Direction	YY_Direction
EI_{effy} (Nmm^2)	Serviceability stiffness derived from the Extended Gamma method	1.31e+12	3.64e+11
EI_{effy} (Nmm^2)	Strength stiffness derived from the Extended Gamma method	1.31e+12	3.64e+11

$$W_{eff} = \frac{I_{eff}}{Max(y_c; h_{CLT} - y_c)}$$

Outer $lamella_{x-x}$	T1	
Outer $lamella_{y-y}$	T2	
$E1_{x-x}$ (N/mm^2)	11000	the outer most longtiudnal lamella stiffness (primary direction)
$E1_{y-y}$ (N/mm^2)	11000	the outer most longtiudnal lamella stiffness (secondary direction)

Section Modulus Properties of CLT		
Z_{eff_XX} (mm^3)	Section modulus: XX_direction	1.71e+6
Z_{eff_YY} (mm^3)	Section modulus: YY_direction	4.28e+5

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	11000	1.49e+6	0.00e+0	1.64e+10	0.00e+0
t_2	mid	366.6666667	1.48e+5	1.63e+3	5.42e+7	5.99e+5
t_3	below yc	11000	0.00e+0	8.72e+5	0.00e+0	9.60e+9
t_4	below yc	366.6666667	0.00e+0	9.75e+5	0.00e+0	3.57e+8
t_5	below yc	11000	0.00e+0	5.88e+5	0.00e+0	6.47e+9
t_6	0	0	0.00e+0	0.00e+0	0.00e+0	0.00e+0
t_7	0	0	0.00e+0	0.00e+0	0.00e+0	0.00e+0

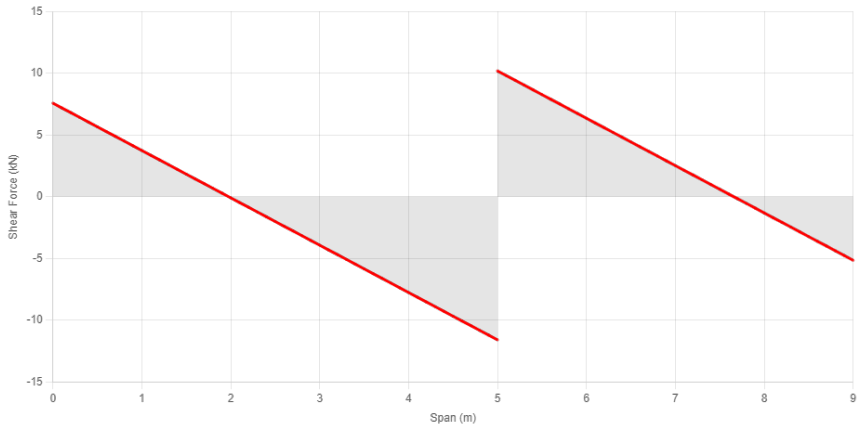
	t (mm)	a (mm)	E (Mpa)	EQ (Nmm)
Mid t upper	17.192392909924	8.5961964549622	366.6666667	5.42e+7
Mid t lower	-1.8076070900756	-0.90380354503778	366.6666667	-5.99e+5

	Max + (Nmm)	Max - (Nmm)	Abs Max (Nmm)
EQ_R	1.64e+10	-1.64e+10	1.64e+10
EQ_L	1.64e+10	-1.64e+10	1.64e+10

Loading

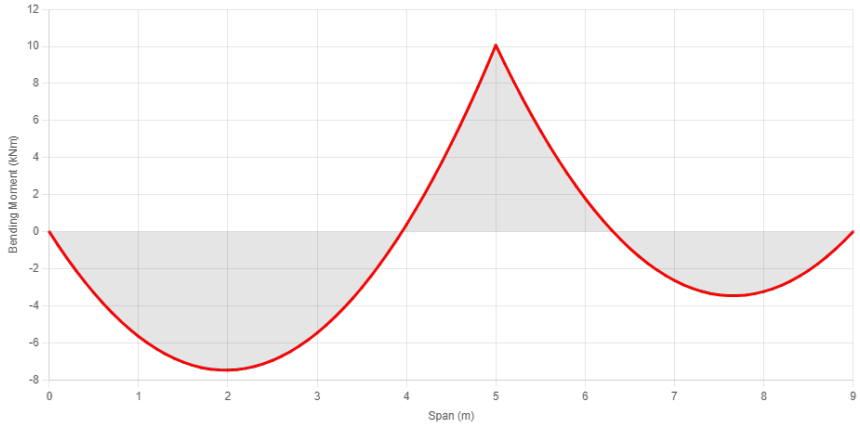
Loading Data	
B_{eff} (mm)	1.0
CLT_{sw} (kPa)	0.64
G (kPa)	2.64
Q (kPa)	2.0
$\Psi_{2,1}$	0.6

Shear Actions



Load Case	1.00G + 0.60Q
Vmax (kN)	11.60

Bending Moment Actions



Load Case	1.00G + 0.60Q
M^*_{max+} (kNm)	10.07
M^*_{max-} (kNm)	-7.48

Bending Design

$$\sigma_{m,y,d} = \frac{E_i}{E_{ref}} \frac{M_{zd}}{W_{x,net}} \quad \longrightarrow \quad \sigma_{m,y,d} = \frac{M^*_{max}}{Z_{eff}} \leq k_{mod,fi} k_{sys} \frac{f_{m,20}}{\gamma_m}$$

k_{sys}
1.15

	Negative Moment (Mid-span)	Positive Moment (Hogging)
Z_{eff} x (mm^3)	1.71e+6	1.71e+6
f'_b (MPa)	24	24
M* (kNm)	-10.07	-10.07
$k_{mod,fi}$	1.00	1.00
γ_{mfi}	1.00	1.00
$f_{m,d}$ [Mpa]	31.74	
$\sigma_{m,d}$- [Mpa]	4.38	
Ratio		*14%*
$f_{m,d}$ [Mpa]	31.74	
$\sigma_{m,d}$+ [Mpa]	-5.90	
Ratio		*19%*

Shear Design

$$\tau_{V,xz,d} = \frac{S_{x,net} V_{xz,d}}{I_{x,net} b_x} \leq f_{v,90,ylay,k} = k_{mod,fi} \frac{f_{v,r,20}}{\gamma_{m,fi}} \quad \longrightarrow \quad \tau_{V,xz,d} = \frac{EQV_{xz,d}}{EI_{effbx}} \leq k_{mod,fi} \frac{fv,r,20}{\gamma_{m,fi}}$$

The formula is transformed to take into account non-homogenous layups.

EI_{eff} (mm^2)	1.31e+12
EQ_L (Nmm)	1.64e+10
f'_s (MPa)	4.00

$k_{mod,fi}$	1.00	
γ_{mfi}	1.00	
$f_{v,d}$ (Mpa)	4.60	
$\tau_{v,r,d}$ (Mpa)	0.15	
Ratio		*3%*

Rolling Shear

EQ_R (Nmm^3)	1.64e+10
f'_r (MPa)	1.25

$k_{mod,fi}$	1.00	
$f_{v,d}$ (Mpa)	1.44	
$\tau_{v,r,d}$ (Mpa)	0.15	
Ratio		*10%*