Supplier / Stock	Grade	b	h
Manual Input	GL30c Euro	500.00 (mm)	500.00 (mm)

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

Column Height	L_{ax}	L_{ay}	Char rate	FRL	ZSL
3 (m)	3.00 (m)	3.00 (m)	0.48 (mm/min)	120 (mins)	7

$\Psi_{2,1}$	k_m	Service Class	k_{sys}	k_{fi}
0.30	0.70	1.00	1.00	1.15 (mins)

Axial Load Above	G	Q	ex	ey
	541.45 (kN)	499.50 (kN)	50.00 (mm)	50.00 (mm)

Connecting Beam Loading

Top Beam

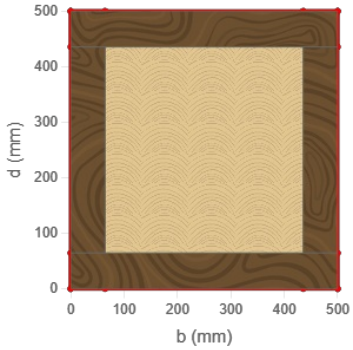
Top Exposed ? Yes — Top Beam ? Yes

G	Q	eb
0.00 (kN)	0.00 (kN)	0.00 (mm)

Left Beam

Left Exposed ? Yes — Left Beam ? Yes

G	Q	eb
100.00 (kN)	100.00 (kN)	250.00 (mm)



Right Beam

Right Exposed ? Yes — Right Beam ? Yes

G	Q	eb
100.00 (kN)	100.00 (kN)	250.00 (mm)

Bottom Beam

Bottom Exposed ? Yes — Bottom Beam ? Yes

G	Q	eb
0.00 (kN)	0.00 (kN)	0.00 (mm)

Outputs Summary

Ambient Axial	Ambient Combined Bending	Ambient Combined Actions	Fire Axial	Fire Combined Bending	Fire Combined Actions
OK	OK	OK	OK	OK	OK
69.7%	41.2%	89.8%	24.6%	19.7%	25.7%

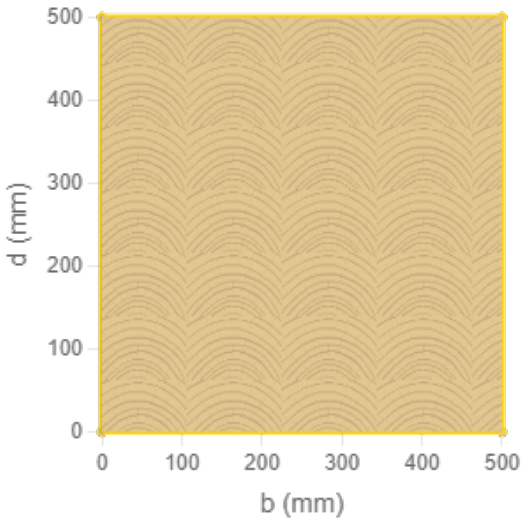
Column Properties (Ambient)

Grade	E_{mean} (MPa)	G_{mean} (MPa)	$f_{m,k}$ (MPa)	$f_{c,0,k}$ (MPa)	$E_{0,05}$ (MPa)	$G_{0,05}$ (MPa)	p_k (kg/m^3)
GL30c Euro	13000	650	30	24.5	9100	910	430

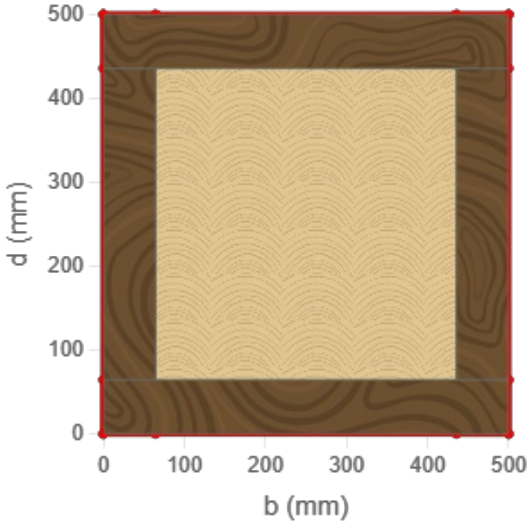
Column Properties (Fire)

Char Layer (mm)	57.6
ZSL (mm)	7.0
Burned Section (mm)	64.6

Panel Properties (Ambient)



Section For Ambient Design



Section For Fire Design

New Properties of column		Ambient	Post Fire Case
b (mm)	Breadth of column	500	370.80
h (mm)	Depth of column	500	370.80

Updated Section Properties		Ambient	Post Fire Case
W_x (mm^3)	Section Modulus x-x	2.08e+7	8.50e+6
W_y (mm^3)	Section Modulus y-y	2.08e+7	8.50e+6
A_c (mm^2)	Area of compression zone	250,000	137,493

Centroid Location		Ambient	Post Fire Case
x (mm)	Breadth of column	250	185.40
y (mm)	Depth of column	250	185.40

Column Forces X-X

Concentric Load (Axial)

Attribute		Ambient	Fire
N^*_G (kN)	Axial G	541.45	541.45
N^*_Q (kN)	Axial Q	499.50	499.50

Direct Load Moment (+)

Attribute		Ambient	Fire
e (mm)	Eccentricity	-50.00	-50.00
M^*_G (kNm)	Moment from Axial G +	-27.07	-27.07
M^*_Q (kNm)	Moment from Axial Q +	-24.97	-24.97

Direct Load Moment (-)

Attribute		Ambient	Fire
e (mm)	Eccentricity	-50.00	-50.00
M^*_G (kNm)	Moment from Axial G -	-27.07	-27.07
M^*_Q (kNm)	Moment from Axial Q -	-24.97	-24.97

Left Face Beam Moment

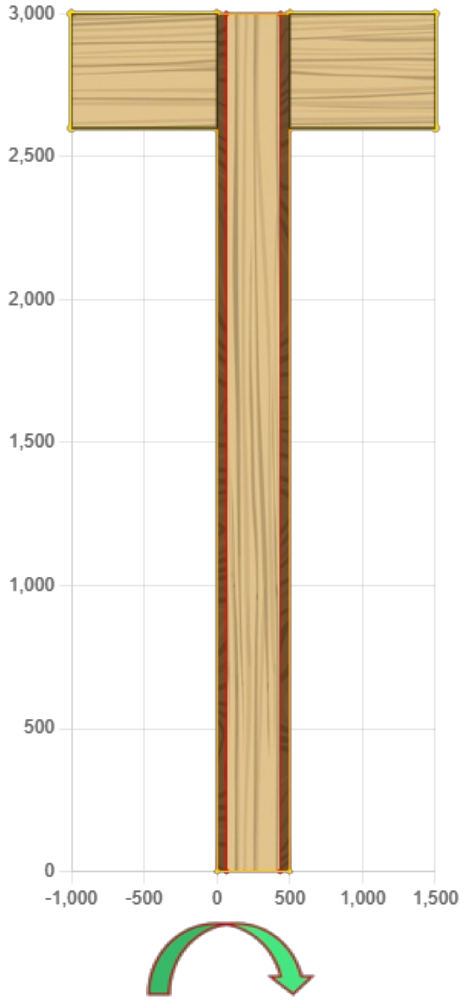
Attribute		Ambient	Fire
e (mm)	Eccentricity	250.00	250.00
M^*_G (kNm)	Moment from Left Beam G	25.00	25.00
M^*_Q (kNm)	Moment from Left Beam Q	25.00	25.00

Right Face Beam Moment

Attribute		Ambient	Fire
e (mm)	Eccentricity	-250.00	-250.00
M^*_G (kNm)	Moment from Right Beam G	-25.00	-25.00
M^*_Q (kNm)	Moment from Right Beam Q	-25.00	-25.00

Resultant Forces

Attribute		Ambient	Fire
N^*_G (kN)	Axial G	741.45	741.45
N^*_Q (kN)	Axial Q	699.50	699.50
M^*_{G+} (kNm)	Net moment G +	-27.07	-27.07
M^*_{G-} (kNm)	Net moment G -	-27.07	-27.07
M^*_{Q+} (kNm)	Net moment Q +	-24.97	-24.97
M^*_{Q-} (kNm)	Net moment Q -	-24.97	-24.97

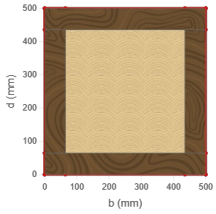


Elevation (X-X)
Applied moments in the fire case shown

	Left Beam	Right Beam
Beam Direction	Across Page	Across Page
B (mm)	400.00	400.00
D (mm)	400.00	400.00
Axis Beginning (mm)	0.00	

Column Section Properties X-X

Attribute		Ambient	Fire
W_x (mm^3)	Section modulus x-x	2.08e+7	8.50e+6
A_c (mm^2)	Area in compression	2.50e+5	1.37e+5



Section X-X

Column Forces Y-Y

Axial Load

Attribute		Ambient	Fire
N^*_G (kN)	Axial G	541.45	541.45
N^*_Q (kN)	Axial Q	499.50	499.50

Direct Load Moment (+)

Attribute		Ambient	Fire
e	Eccentricity	-50.00	-50.00
M^*_G (kNm)	Moment from Axial G +	-27.07	-27.07
M^*_Q (kNm)	Moment from Axial Q +	-24.97	-24.97

Direct Load Moment (-)

Attribute		Ambient	Fire
e	Eccentricity	-50.00	-50.00
M^*_G (kNm)	Moment from Axial G -	-27.07	-27.07
M^*_Q (kNm)	Moment from Axial G -	-24.97	-24.97

Top Face Beam Moment

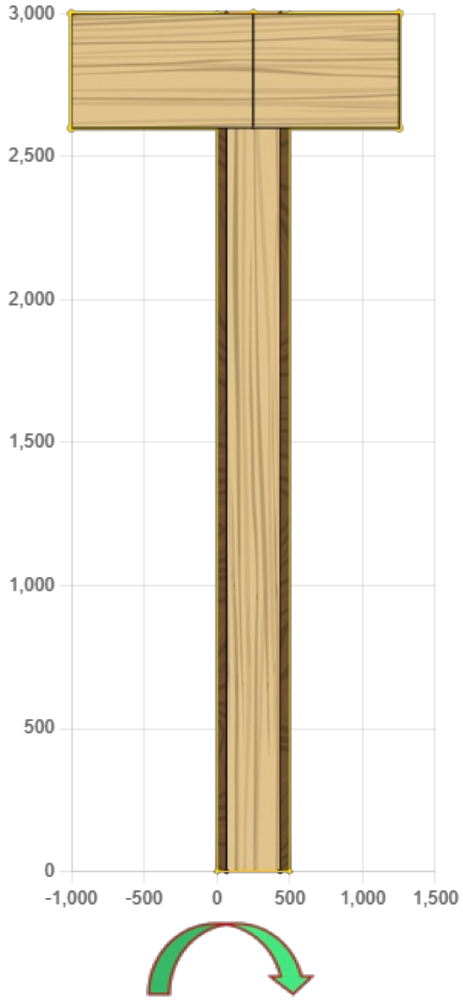
Attribute		Ambient	Fire
e	Eccentricity	0.00	0.00
M^*_G (kNm)	Moment from Top Beam G	0.00	0.00
M^*_Q (kNm)	Moment from Top Beam Q	0.00	0.00

Bottom Face Beam Moment

Attribute		Ambient	Fire
e	Eccentricity	0.00	0.00
M^*_G (kNm)	Moment from Bottom Beam G	0.00	0.00
M^*_Q (kNm)	Moment from Bottom Beam Q	0.00	0.00

Resultant Forces

Attribute		Ambient	Fire
N^*_G (kN)	Axial G	741.45	741.45
N^*_Q (kN)	Axial Q	699.50	699.50
M^*_{G+} (kNm)	Net moment G +	-27.07	-27.07
M^*_{G-} (kNm)	Net moment G -	-27.07	-27.07
M^*_{Q+} (kNm)	Net moment Q +	-24.97	-24.97
M^*_{Q-} (kNm)	Net moment Q -	-24.97	-24.97

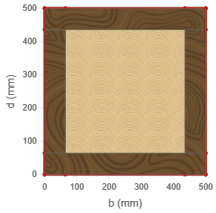


Elevation (Y-Y)
Applied moments in the fire case shown

	Left Beam	Right Beam
Beam Direction	Across Page	Across Page
B (mm)	400.00	400.00
D (mm)	400.00	400.00
Axis Beginning (mm)	0.00	

Column Section Properties Y-Y

Attribute		Ambient	Fire
W_y (mm^3)	Section modulus y-y	2.08e+7	8.50e+6
A_c (mm^2)	Area in compression	2.50e+5	1.37e+5



Section Y-Y

Calculate Slenderness EUROCODE 5

Properties of Column		Ambient	Post Fire
g_{13}	Effective length factor	1.00	1.00
A_c (mm^2)	Area in compression	250000.00	137492.64
$f_{c,0,k}$ (MPa)	Compressive strength	24.50	24.50
$f_{m,0,k}$ (MPa)	Bending strength	30.00	30.00
E_{05} (MPa)	Fifth percentile modulus of elasticity	9100.00	9100.00
G_{05} (MPa)	Fifth percentile shear modulus	910.00	910.00

$$i_x = \sqrt{\frac{I}{A}} \qquad \lambda_x = \frac{Lx}{i_x}$$

Slenderness In x-x		Ambient	Post Fire
L_x (mm)	Height of column (mm)	3000.00	3000.00
I_x (mm^4)	Second moment of area about the x axis	5.21e+9	1.58e+9
W_x (mm^3)	Section modulus of the column about x-x	2.08e+7	8.50e+6
i_x	Radius of gyration about the x-x axis	144.34	107.04
λ_x	Slenderness ratio about the x-x axis	20.78	28.03

Slenderness In y-y		Ambient	Post Fire
L_y (mm)	Height of column (mm)	3000.00	3000.00
I_y (mm^4)	Second moment of area about the y axis	5.21e+9	1.58e+9
W_y (mm^3)	Section modulus of the column about y-y	2.08e+7	8.50e+6
i_y	Radius of gyration about the y-y axis	144.34	107.04
λ_y	Slenderness ratio about the y-y axis	20.78	28.03

$$\lambda_{rel,y} = \frac{\lambda_y}{\pi}\sqrt{\frac{fc,0,gk}{E_{0.05g}}} \qquad \lambda_{rel,x} = \frac{\lambda_x}{\pi}\cdot\sqrt{\frac{fc,0,gk}{E_{0.05g}}}$$

Relative Slenderness Values		Ambient	Post Fire
$\lambda_{rel\ x\text{-}x}$	Relative slenderness about the x-x axis	0.34	0.46
$\lambda_{rel\ y\text{-}y}$	Relative slenderness about the y-y axis	0.34	0.46

$$k_x = 0.5(1 + \beta_c(\lambda_{rel,x} - 0.3) + \lambda_{rel,x}^2)$$

Calculate factor k		Ambient	Post Fire
β_c	Factor β_c for glulam	0.10	0.10
k_x	Factor k_x	0.56	0.62
k_y	Factor k_y	0.56	0.62

$$k_{cy} = \frac{1}{k_y\sqrt{k_y^2\lambda_{rel,y}^2}}$$

Calculate instability factor		Ambient	Post Fire
k_{cx}	Instability factor about the x-x axis	1.00	0.98
k_{cy}	Instability factor about the y-y axis	1.00	0.98

$$K_{1,edge} = \frac{1}{3}\left(1 - \frac{0.63b}{d}\right) \qquad I_{torr,edge} = K_{1,edge}db^3$$

Calculate torsional moment of area.		Ambient	Post Fire
$K_{1,edge}{}^{x\text{-}x}$	K1edge factor - edge case	0.12	0.12
$I_{tor,edge}$	Torsional moment of inertia for rectangular cross sections	7.71e+9	2.33e+9
$K_{1,edge}{}^{x\text{-}x}$	K1edge factor - edge case	0.123	0.123
$I_{tor,flat}$	Torsional moment of inertia for rectangular cross sections	7.71e+9	2.33e+9

$$\sigma_{m,x,crit} = \frac{M_{x,crit}}{W_x} = \pi \frac{\sqrt{E_{0.05,flat} I_y G_{0.05} I_{tor,edge}}}{l_{ef} W_x} \qquad \sigma_{m,ycrit} = \frac{M_{y,crit}}{W_y} = \pi \frac{\sqrt{E_{0.05,flat} I_x G_{0.05} I_{tor,flat}}}{l_{ef} W_y}$$

Calculate critical bending stress		Ambient	Post Fire
$\sigma_{m,xcrit}$ (MPa)	The critical bending stress (x)	916.5	679.7
$\sigma_{m,ycrit}$ (MPa)	The critical bending stress (y)	916.5	679.7

$$\lambda_{rel,m} = min(\sqrt{\frac{fm,k,x}{\sigma_{m,crit,x}}}, \sqrt{\frac{fm,k,y}{\sigma_{m,crit,y}}})$$

Calculate relative slenderness for bending		Ambient	Post Fire
$\lambda_{rel,\ x\text{-}x}$	The critical bending stress (x)	0.181	0.210
$\lambda_{rel,\ x\text{-}x}$	The critical bending stress (y)	0.181	0.210

$$\begin{array}{lcl} \lambda_{rel,m} \leq 0.75 & \longrightarrow & 1 \\ 0.75 < \lambda_{rel,m} \leq 1.4 & \longrightarrow & 1.56 - 0.75\lambda_{rel,m} \\ \lambda_{rel,m} > 1.4 & \longrightarrow & \frac{1}{\lambda^2_{rel,m}} \end{array}$$

Ambient		*Post Fire*	
xx	yy	xx	yy
1	1	1	1

Calculate k_{crit}		Ambient	Post Fire
$k_{crit\ x}$	Lateral buckling reduction factor (minimum)	1.00	1.00
$k_{crit\ y}$	Lateral buckling reduction factor (minimum)	1.00	1.00

Compression Parallel to Grain

ksys	kh,x	kh,y	γm	km	kfi
1	1.02	1.02	1.25	0.70	1.15

direction	xx	yy
$A_{ambient}$ (mm^2)	2.50e+5	2.50e+5
A_{fire} (mm^2)	1.37e+5	1.37e+5
$f_{c,0,k}$ (MPa)	24.50	24.50
$f_{m,0,k}$ (MPa)	30.00	30.00

$$\sigma_{c,0,d} =\leq f_{c,0,d}$$

$$f_{c,0,d} = \frac{k_{sys} k_{mod} f_{c,0,k}}{\gamma_m} \qquad \sigma_{c,0,d} = \frac{F_{c,d}}{A_{tot}}$$

Load Combinations	1.35G + 1.50Q	1.00G + 0.30Q
k_{mod} or $k_{mod,fi}$	0.60	1.00
γM or γM,fi	1.25	1.00
$f_{c,0,d}$ (N/mm^2)	11.76	28.17
$F_{c,d}$ (kN)	2050.21	951.30
$\sigma_{c,0,d}$- (N/mm^2)	8.20	6.92
Ratio	*70%*	*25%*

70%	*Ambient*
25%	*Fire*

Combined Bending Checks

$$Ratio1 : \frac{\sigma_{m,x,d}}{f_{m,x,d}} + k_m \frac{\sigma_{m,y,d}}{f_{m,y,d}} \leq 1 \qquad Ratio2 : k_m \frac{\sigma_{m,x,d}}{f_{m,x,d}} + \frac{\sigma_{m,y,d}}{f_{m,y,d}} \leq 1$$

$$f_{m,x,d} = \frac{k_{sys} k_{h,x} k_{mod} f_{m,0,k}}{\gamma_m}$$

$$\sigma_{m,x,d} = \frac{M_{max-x}}{W_x}$$

EN 1995-1-1:2004 6.1.6

Load Combinations	1.35G + 1.50Q	1.00G + 0.30Q
W_x (mm^3)	2.08e+7	8.50e+6
k_{mod} or $k_{mod,fi}$	0.60	1.00
γM or γM,fi	1.25	1.00
$f_{m,x,d}$	14.66	35.13
M^*_{max-x}+ (kNm)	-74.01	-34.57
$\sigma_{m,x,d}$+ (MPa)	-3.55	-4.07
M^*_{max-x}- (kNm)	-74.01	-34.57
$\sigma_{m,x,d}$- (MPa)	-3.55	-4.07
Ratio	*24%*	*12%*

Load Combinations	1.35G + 1.50Q	1.00G + 0.30Q
k_{mod} or $k_{mod,fi}$	0.60	1.00
γM or γM,fi	1.25	1.00
$f_{m,y,d}$	14.66	35.13
M^*_{max-y}+ (kNm)	-74.01	-34.57
$\sigma_{m,y,d}$+ (MPa)	-3.55	-4.07
M^*_{max-y}- (kNm)	-74.01	-34.57
$\sigma_{m,y,d}$- (MPa>)	-3.55	-4.07
Ratio	*24%*	*12%*

Load Combinations	1.35G + 1.50Q	1.00G + 0.30Q
Ratio 1	41.18%	19.68%
Ratio 2	41.2%	19.7%

41%	*Ambient*
20%	*Fire*

Combined Stress Condition (Bending and Compression)

$$Ratio1 : (\frac{\sigma_{c,0,d}}{f_{c,0,d}})^2 + \frac{\sigma_{m,x,d}}{f_{m,x,d}} + k_m \frac{\sigma_{m,y,d}}{f_{m,y,d}} \leq 1 \qquad Ratio2 : (\frac{\sigma_{c,0,d}}{f_{c,0,d}})^2 + k_m \frac{\sigma_{m,x,d}}{f_{m,x,d}} + \frac{\sigma_{m,y,d}}{f_{m,y,d}} \leq 1$$

Load Combinations	1.35G + 1.50Q	1.00G + 0.30Q
Ratio 1	89.81%	25.71%
Ratio 2	89.8%	25.7%

90%	*Ambient*
26%	*Fire*

Buckling Of Columns

The stability of columns subjected to either compression or combined compression and bending should be verified in accordance with 6.3.2.

$$Ratio1 : \frac{\sigma_{c,0,d}}{k_{c,x} f_{c,0,d}} + \frac{\sigma_{m,x,d}}{f_{m,x,d}} + k_m \frac{\sigma_{m,y,d}}{f_{m,y,d}} \leq 1 \qquad Ratio2 : \frac{\sigma_{c,0,d}}{k_{c,y} f_{c,0,d}} + k_m \frac{\sigma_{m,x,d}}{f_{m,x,d}} + \frac{\sigma_{m,y,d}}{f_{m,y,d}} \leq 1$$

EN 1995-1-1:2004 6.3.2

Load Combinations	1.35G + 1.50Q	1.00G + 0.30Q
$k_{c\ x}$	1.00	0.98
Ratio $1_{x\text{-}x}$	111.26%	44.75%
$k_{c\ y}$	1.00	0.98
Ratio $2_{y\text{-}y}$	111.26%	44.75%

111%	*Ambient*
45%	*Fire*

Lateral Torsional Buckling Of Columns

The lateral torsional stability of columns subjected to either bending or combined bending and compression should be verified in accordance with 6.3.3.

$$Ratio1 : (\frac{\sigma_{m,x,d}}{k_{crit} f_{m,x,d}})^2 + \frac{\sigma_{c,0,d}}{k_{c,y} f_{c,0,d}} \leq 1 \qquad Ratio2 : (\frac{\sigma_{m,y,d}}{k_{crit} f_{m,y,d}})^2 + \frac{\sigma_{c,0,d}}{k_{c,x} f_{c,0,d}} \leq 1$$

EN 1995-1-1:2004 6.3.3

Load Combinations	1.35G + 1.50Q	1.00G + 0.30Q
$k_{crit\ x}$	1.00	1.00
Ratio $1_{x\text{-}x}$	75.95%	26.40%
$k_{crit\ y}$	1.00	1.00
Ratio $2_{y\text{-}y}$	75.95%	26.40%

76%	*Ambient*
26%	*Fire*