

C.20.1

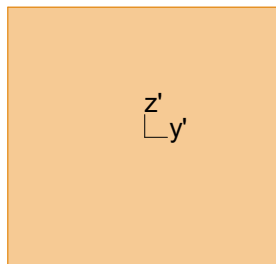
Maximum of load combinations

GL 32c

(Glued laminated), Service class 1

$E_{0,05}$	=	11200 N/mm ²	$f_{t,90,k}$	=	0.50 N/mm ²
$G_{0,05}$	=	540 N/mm ²	$f_{c,0,k}$	=	24.50 N/mm ²
Y_M	=	1.15	$f_{c,90,k}$	=	2.50 N/mm ²
$Y_{M,acc./seis.}$	=	1.00	$f_{v,k}$	=	3.50 N/mm ²
k_{sys}	=	1.00			

Glulam 190x180



A	=	34200 mm ²	$f_{t,0,k}$	=	21.45 N/mm ²
W_1	=	1.083e+06 mm ³	$f_{m,1,k}$	=	35.20 N/mm ²
W_2	=	1.026e+06 mm ³	$f_{m,2,k}$	=	35.20 N/mm ²
i_1	=	55 mm			
i_2	=	52 mm			
I_2	=	9.234e+07 mm ⁴			
I_t	=	1.642e+08 mm ⁴			

Combined bending and axial tension - 6.2.3

Not relevant

Combined bending and axial compression - 6.1.4, 6.2.4

LC: 'LC8ULS', $k_{mod} = 0.90$, $x = 0.00$ mm

$$\sigma_{c,0,d} = 14.40 \text{ N/mm}^2 \leq f_{c,0,d} = 19.17 \text{ N/mm}^2 \quad (6.2) - \text{OK}$$

$$\left(\frac{\sigma_{c,0,d}}{f_{c,0,d}} \right)^2 + \frac{\sigma_{m,1,d}}{f_{m,1,d}} + k_m \frac{\sigma_{m,2,d}}{f_{m,2,d}} = \left(\frac{14.40}{19.17} \right)^2 + \frac{0.37}{27.55} + 0.70 \frac{0.17}{27.55} = 0.58 \leq 1.00 \quad (6.19) - \text{OK}$$

$$\left(\frac{\sigma_{c,0,d}}{f_{c,0,d}} \right)^2 + k_m \frac{\sigma_{m,1,d}}{f_{m,1,d}} + \frac{\sigma_{m,2,d}}{f_{m,2,d}} = \left(\frac{14.40}{19.17} \right)^2 + 0.70 \frac{0.37}{27.55} + \frac{0.17}{27.55} = 0.58 \leq 1.00 \quad (6.20) - \text{OK}$$

Combined shear and torsion - 6.1.7, 6.1.8

LC: 'LC22ULS', $k_{mod} = 0.90$, $x = 3000.00$ mm

$$\tau_d = 0.26 \text{ N/mm}^2 \leq f_{v,d} = 2.74 \text{ N/mm}^2 \quad (6.13) - \text{OK}$$

Flexural buckling around axis 1 - 6.3.2

LC: 'LC8ULS', $k_{mod} = 0.90$, $x = 0.00$ mm

$$\beta_c = 0.1 \quad (6.29)$$

$$\lambda_1 = \frac{l_0}{i_1} = \frac{3000}{55} = 54.70$$

$$\lambda_{rel,1} = \frac{\lambda_1}{\pi} \sqrt{\frac{f_{c,0,k}}{E_{0,05}}} = \frac{54.70}{\pi} \sqrt{\frac{24.50}{11200}} = 0.814 \quad (6.21)$$

$$k_1 = 0.5 \left(1 + \beta_c (\lambda_{rel,1} - 0.3) + \lambda_{rel,1}^2 \right) = 0.5 \left(1 + 0.1 (0.814 - 0.3) + 0.814^2 \right) = 0.857 \quad (6.27)$$

$$k_{c,1} = \frac{1}{k_1 + \sqrt{k_1^2 - \lambda_{rel,1}^2}} = \frac{1}{0.857 + \sqrt{0.857^2 - 0.814^2}} = 0.889 \quad (6.25)$$

$$\frac{\sigma_{c,0,d}}{k_{c,1} \cdot f_{c,0,d}} + \frac{\sigma_{m,1,d}}{f_{m,1,d}} + k_m \cdot \frac{\sigma_{m,2,d}}{f_{m,2,d}} = \frac{14.40}{0.889 \cdot 19.17} + \frac{0.37}{27.55} + 0.70 \cdot \frac{0.17}{27.55} = 0.86 \leq 1.00 \quad (6.23) - \text{OK}$$

Flexural buckling around axis 2 - 6.3.2

LC: 'LC8ULS', $k_{mod} = 0.90$, $x = 0.00$ mm

$$\beta_c = 0.1 \quad (6.29)$$

$$\lambda_2 = \frac{l_0}{i_2} = \frac{3000}{52} = 57.74$$

$$\lambda_{rel,2} = \frac{\lambda_2}{\pi} \sqrt{\frac{f_{c,0,k}}{E_{0,05}}} = \frac{57.74}{\pi} \sqrt{\frac{24.50}{11200}} = 0.860 \quad (6.22)$$

$$k_2 = 0.5 \left(1 + \beta_c (\lambda_{rel,2} - 0.3) + \lambda_{rel,2}^2 \right) = 0.5 \left(1 + 0.1 (0.860 - 0.3) + 0.860^2 \right) = 0.897 \quad (6.28)$$

$$k_{c,2} = \frac{1}{k_2 + \sqrt{k_2^2 - \lambda_{rel,2}^2}} = \frac{1}{0.897 + \sqrt{0.897^2 - 0.860^2}} = 0.866 \quad (6.26)$$

$$\frac{\sigma_{c,0,d}}{k_{c,2} \cdot f_{c,0,d}} + k_m \cdot \frac{\sigma_{m,1,d}}{f_{m,1,d}} + \frac{\sigma_{m,2,d}}{f_{m,2,d}} = \frac{14.40}{0.866 \cdot 19.17} + 0.70 \cdot \frac{0.37}{27.55} + \frac{0.17}{27.55} = 0.88 \leq 1.00 \quad (6.24) - \text{OK}$$

Lateral torsional buckling - 6.3.3

LC: 'LC8ULS', $k_{mod} = 0.90$, $x = 0.00$ mm

$$l_{ef} = l / \frac{12.5 \cdot M_{max}}{2.5 \cdot M_{max} + 3 \cdot M_2 + 4 \cdot M_3 + 3 \cdot M_4} + 2 \cdot h = 3000 / \frac{12.5 \cdot 0.41}{2.5 \cdot 0.41 + 3 \cdot 0.13 + 4 \cdot 0.04 + 3 \cdot 0.06} + 2 \cdot 190 = 1421 \text{ mm}$$

$$\sigma_{m,crit} = \frac{\pi \sqrt{E_{0,05} \cdot I_2 \cdot G_{0,05} \cdot I_t}}{l_{ef} \cdot W_1} = \frac{\pi \sqrt{11200 \cdot 9.234e+07 \cdot 540 \cdot 1.642e+08}}{1421 \cdot 1.083e+06} = 618.29 \text{ N/mm}^2 \quad (6.31)$$

$$\lambda_{rel,m} = \sqrt{\frac{f_{m,1,k}}{\sigma_{m,crit}}} = \sqrt{\frac{32.00}{618.29}} = 0.227 \quad (6.30)$$

$$\lambda_{rel,m} = 0.227 \leq 0.75 \rightarrow k_{crit} = 1.000 \quad (6.34)$$

$$\frac{\sigma_{m,1,d}}{k_{crit} \cdot f_{m,1,d}} = \frac{0.37}{1.000 \cdot 27.55} = 0.01 \leq 1.00 \quad (6.33) - \text{OK}$$

$$\left(\frac{\sigma_{m,1,d}}{k_{crit} \cdot f_{m,1,d}} \right)^2 + \frac{\sigma_{c,0,d}}{k_{c,2} \cdot f_{c,0,d}} = \left(\frac{0.37}{1.000 \cdot 27.55} \right)^2 + \frac{14.40}{0.87 \cdot 19.17} = 0.87 \leq 1.00 \quad (6.35) - \text{OK}$$

Bending at apex - 6.4.3

Not relevant

Tension at apex - 6.4.3

Not relevant

Summary

