

B.206.1

Maximum of load combinations

S 355

$$E = 210000 \text{ N/mm}^2$$

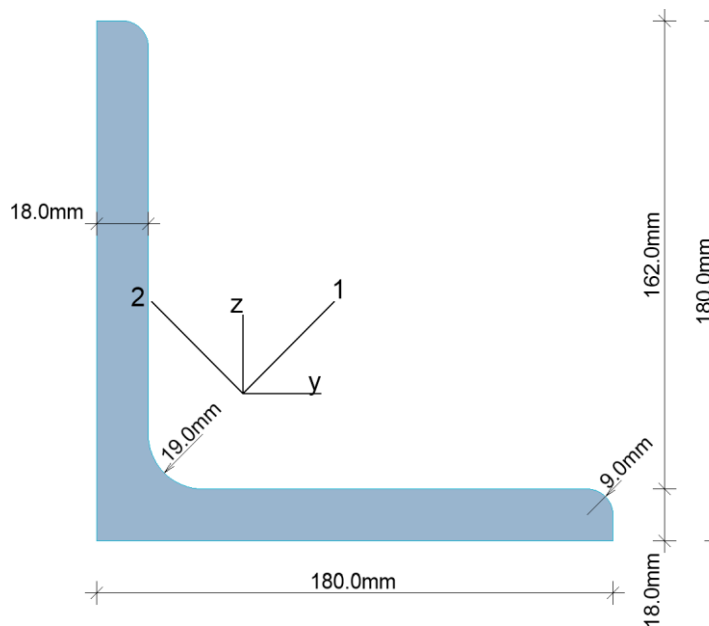
$$G = 80769 \text{ N/mm}^2$$

$$\gamma_{M0,ult} = 1.00 \quad \gamma_{M0,acc/seis} = 1.00$$

$$\gamma_{M1,ult} = 1.00 \quad \gamma_{M1,acc/seis} = 1.00$$

$$\gamma_{M2,ult} = 1.25 \quad \gamma_{M2,acc/seis} = 1.00$$

LE 180*18



$$P = 704 \text{ mm} \quad f_y = 355 \text{ N/mm}^2$$

$$A = 6199 \text{ mm}^2 \quad \varepsilon = 0.81$$

$$I_y = 1.866e+07 \text{ mm}^4 \quad \lambda_1 = 76.40$$

$$I_z = 1.866e+07 \text{ mm}^4$$

$$I_1 = 2.963e+07 \text{ mm}^4$$

$$I_2 = 7.694e+06 \text{ mm}^4$$

$$W_{pl,1} = 3.688e+05 \text{ mm}^3$$

$$W_{pl,2} = 1.888e+05 \text{ mm}^3$$

$$W_{el,min,1} = 2.328e+05 \text{ mm}^3$$

$$W_{el,min,2} = 1.067e+05 \text{ mm}^3$$

$$i_1 = 69 \text{ mm}$$

$$i_2 = 35 \text{ mm}$$

$$I_t = 7.030e+05 \text{ mm}^4$$

$$I_w = 1.526e+09 \text{ mm}^6$$

Shear resistance, 1-1 - Part 1-1: 6.2.6, 6.2.8

Not relevant

Shear resistance, 2-2 - Part 1-1: 6.2.6, 6.2.8

Not relevant

Torsional resistance - Part 1-1: 6.2.7

LC: '6.10 a Y+ wind down ', $x = 0 \text{ mm}$

Class_N = 2, Class_{M1} = 3, Class_{M2} = 1

$$\tau_{max,unit} = 38.56 \frac{\text{N/mm}^2}{\text{kNm}} \quad \text{is calculated by FEM analysis.}$$

$$T_{Rd} = \frac{f_y}{\sqrt{3} \cdot \tau_{max,unit} \cdot \gamma_{M0}} = \frac{355}{\sqrt{3} \cdot 38.56 \cdot 1.00} = 5.31 \text{ kNm}$$

$$\frac{T_{Ed}}{T_{Rd}} = \frac{0.00}{5.31} = 0.00 \leq 1.00 \quad (6.23) - \text{OK}$$

Shear stress - Part 1-1: 6.2.6LC: '6.10 a Y+ wind down ', $x = 0$ mmClass_N = 2, Class_{M1} = 3, Class_{M2} = 1

$$\frac{\tau_{Ed}}{(f_y/\sqrt{3})/\gamma_{M0}} = \frac{80.02}{(355/\sqrt{3})/1.00} = 0.39 \leq 1.00 \quad (6.19) - \text{OK}$$

Normal stress - Part 1-1: 6.2.1

Not relevant

Pure normal resistance - Part 1-1: 6.2.3, 6.2.4

Not relevant

Normal capacity - Part 1-1: 6.2LC: 'ULS elementi', $x = 733$ mmClass_N = 2, Class_{M1} = 3, Class_{M2} = 1

$$\tau_{Rd} = \frac{f_y}{\sqrt{3} \cdot \gamma_{M0}} = \frac{355}{\sqrt{3} \cdot 1.00} = 204.96 \text{ N/mm}^2$$

$$\tau_{Ed} = 17.18 \text{ N/mm}^2 \leq 0.5 \cdot \tau_{Rd} = 0.5 \cdot 204.96 = 102.48 \text{ N/mm}^2 \rightarrow \rho_1 = 0.00$$

$$\tau_{Ed} = 17.18 \text{ N/mm}^2 \leq 0.5 \cdot \tau_{Rd} = 0.5 \cdot 204.96 = 102.48 \text{ N/mm}^2 \rightarrow \rho_2 = 0.00$$

$$\frac{N_{Ed}}{N_{Rd}} + \frac{M_{1,Ed}}{M_{1,Rd}} + \frac{M_{2,Ed}}{M_{2,Rd}} = \frac{0.00}{2200.54} + \frac{27.79}{82.64} + \frac{27.79}{67.01} = 0.75 \leq 1.00 \quad (6.2) - \text{OK}$$

Flexural buckling, 1-1 - Part 1-1: 6.3.1LC: '6.10 a Y+ wind down ', $x = 0$ mmClass_N = 2, Class_{M1} = 3, Class_{M2} = 1

$$\bar{\lambda}_1 = \frac{L_{cr,1}}{i_1 \lambda_1} = \frac{1100}{69 \cdot 76.40} = 0.21 \quad (6.50)$$

$$\alpha_1 = 0.34 \quad (\text{Buckling curve: b})$$

$$\varphi_1 = 0.5 \left[1 + \alpha_1 \cdot (\bar{\lambda}_1 - 0.2) + \bar{\lambda}_1^2 \right] = 0.5 \left[1 + 0.34 \cdot (0.21 - 0.2) + 0.21^2 \right] = 0.52$$

$$\chi_1 = \min \left(\frac{1}{\varphi_1 + \sqrt{\varphi_1^2 - \bar{\lambda}_1^2}}, 1.0 \right) = \min \left(\frac{1}{0.52 + \sqrt{0.52^2 - 0.21^2}}, 1.0 \right) = 1.00 \quad (6.49)$$

$$N_{b,Rd,1} = \frac{\chi_1 \cdot A \cdot f_y}{\gamma_{M1}} = \frac{1.00 \cdot 6199 \cdot 355}{1.00} = 2194.10 \text{ kN} \quad (6.47)$$

$$\frac{N_{Ed}}{N_{b,Rd,1}} = \frac{0.00}{2194.10} = 0.00 \leq 1.00 \quad (6.46) - \text{OK}$$

Flexural buckling, 2-2 - Part 1-1: 6.3.1LC: '6.10 a Y+ wind down ', $x = 0$ mmClass_N = 2, Class_{M1} = 3, Class_{M2} = 1

$$\bar{\lambda}_2 = \frac{L_{cr,2}}{i_2 \lambda_1} = \frac{1100}{35 \cdot 76.40} = 0.41 \quad (6.50)$$

$$\alpha_2 = 0.34 \quad (\text{Buckling curve: b})$$

$$\varphi_2 = 0.5 \left[1 + \alpha_2 \cdot (\bar{\lambda}_2 - 0.2) + \bar{\lambda}_2^2 \right] = 0.5 \left[1 + 0.34 \cdot (0.41 - 0.2) + 0.41^2 \right] = 0.62$$

$$\chi_2 = \min \left(\frac{1}{\varphi_2 + \sqrt{\varphi_2^2 - \bar{\lambda}_2^2}}, 1.0 \right) = \min \left(\frac{1}{0.62 + \sqrt{0.62^2 - 0.41^2}}, 1.0 \right) = 0.92 \quad (6.49)$$

$$N_{b,Rd,2} = \frac{\chi_2 \cdot A \cdot f_y}{\gamma_{M1}} = \frac{0.92 \cdot 6199 \cdot 355}{1.00} = 2030.26 \text{ kN} \quad (6.47)$$

$$\frac{N_{Ed}}{N_{b,Rd,2}} = \frac{0.00}{2030.26} = 0.00 \leq 1.00 \quad (6.46) - \text{OK}$$

Torsional-flexural buckling - Part 1-1: 6.3.1

LC: '6.10 a Y+ wind down ', $x = 0$ mm

Class_N = 2, Class_{M1} = 3, Class_{M2} = 1

$$i_0 = \sqrt{i_1^2 + i_2^2 + y_0^2 + z_0^2} = \sqrt{69^2 + 35^2 + 0^2 + 57^2} = 97 \text{ mm}$$

$$N_{cr,1} = \frac{\pi^2 \cdot E \cdot I_1}{L_{cr,1}^2} = \frac{\pi^2 \cdot 210000 \cdot 29629502}{1100^2} = 50752.57 \text{ kN}$$

$$N_{cr,2} = \frac{\pi^2 \cdot E \cdot I_2}{L_{cr,2}^2} = \frac{\pi^2 \cdot 210000 \cdot 7694219}{1100^2} = 13179.48 \text{ kN}$$

$$N_{cr,T} = \frac{1}{i_0^2} \left(G \cdot I_t + \frac{\pi^2 \cdot E \cdot I_w}{L_t^2} \right) = \frac{1}{97^2} \left(80769 \cdot 7.030e + 05 + \frac{\pi^2 \cdot 210000 \cdot 1.526e + 09}{1100^2} \right) = 6372.41 \text{ kN}$$

$$\begin{aligned} i_0^2 (N - N_{cr,1}) (N - N_{cr,2}) (N - N_{cr,T}) - N^2 y_0^2 (N - N_{cr,2}) - N^2 z_0^2 (N - N_{cr,1}) \\ = 97^2 (N - 50752.57) (N - 13179.48) (N - 6372.41) - N^2 0^2 (N - 13179.48) \\ - N^2 57^2 (N - 50752.57) = 0 \end{aligned}$$

Smallest root of the above equation related to the torsional-flexural buckling:

$$N_{cr,TF} = 5183.24 \text{ kN}$$

$$N_{cr} = \min(N_{cr,T}, N_{cr,TF}) = \min(6372.41, 5183.24) = 5183.24 \text{ kN}$$

$$\bar{\lambda}_T = \sqrt{\frac{A \cdot f_y}{N_{cr}}} = \sqrt{\frac{6199 \cdot 355}{5183.24}} = 0.65 \quad (6.53)$$

$$\alpha_T = 0.34 \quad (\text{Buckling curve: b})$$

$$\varphi_T = 0.5 \left[1 + \alpha_T \cdot (\bar{\lambda}_T - 0.2) + \bar{\lambda}_T^2 \right] = 0.5 \left[1 + 0.34 \cdot (0.65 - 0.2) + 0.65^2 \right] = 0.79$$

$$\chi_T = \min \left(\frac{1}{\varphi_T + \sqrt{\varphi_T^2 - \bar{\lambda}_T^2}}, 1.0 \right) = \min \left(\frac{1}{0.79 + \sqrt{0.79^2 - 0.65^2}}, 1.0 \right) = 0.81 \quad (6.49)$$

$$N_{b,Rd,T} = \frac{\chi_T \cdot A \cdot f_y}{\gamma_{M1}} = \frac{0.81 \cdot 6199 \cdot 355}{1.00} = 1783.17 \text{ kN} \quad (6.47)$$

$$\frac{N_{Ed}}{N_{b,Rd,T}} = \frac{0.00}{1783.17} = 0.00 \leq 1.00 - \text{OK}$$

Lateral torsional buckling, top flange - Part 1-1: 6.3.2.4

Not relevant

Lateral torsional buckling, bottom flange - Part 1-1: 6.3.2.4

Not relevant

Interaction between normal force and bending 1. - Part 1-1: 6.3.3

Not relevant

Interaction between normal force and bending 2. - Part 1-1: 6.3.3

Not relevant

Interaction between normal force and bending, 2nd order - Part 1-1: 6.3.3

Not relevant

Shear buckling - Part 1-5: 5

Shear buckling check is not implemented for this section.

Summary

