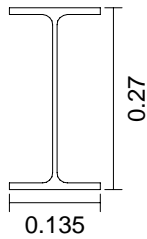


Cross section: IPE 270

$h = 270.0 \text{ mm}$
 $b = 135.0 \text{ mm}$
 $s = 6.6 \text{ mm}$
 $t = 10.2 \text{ mm}$
 $r = 15.0 \text{ mm}$

$A = 45.9 \text{ cm}^2$

$I_y = 5790.0 \text{ cm}^4$

$I_z = 420.0 \text{ cm}^4$

$I_T = 16.0 \text{ cm}^4$

$I_{\omega} = 70580 \text{ cm}^6$

$i_z = 3.02 \text{ cm}$

$i_p = 11.63 \text{ cm}$

$i_M = 11.63 \text{ cm}$

Material: S235

$f_{y,k} = 240 \text{ N/mm}^2$

E-Modulus = 210000 N/mm^2

G-Modulus = 81000 N/mm^2

$\gamma_M = 1.10$

Load in z-direction

$L = 8.00 \text{ m}$

$N_d = 0.00 \text{ kN}$

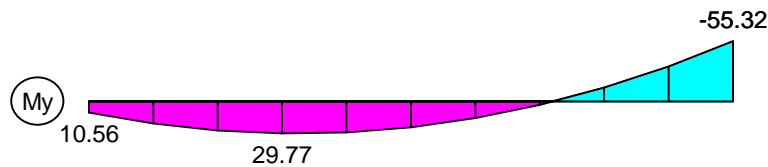
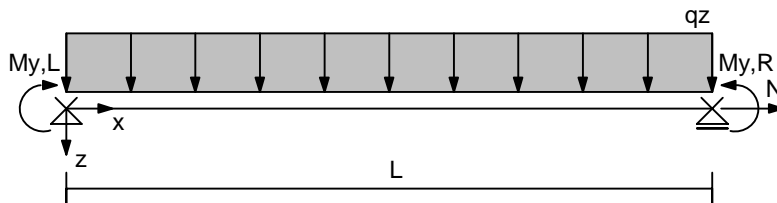
$q_{z,d} = 5.80 \text{ kN/m}$

$M_{y,d,\text{left}} = 10.56 \text{ kNm}$

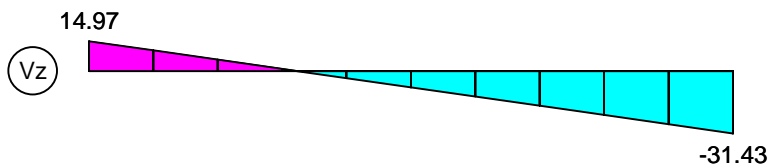
$M_{y,d,\text{right}} = -55.32 \text{ kNm}$

The load application point is in the shear center $\Rightarrow z_p = 0.00 \text{ cm}$

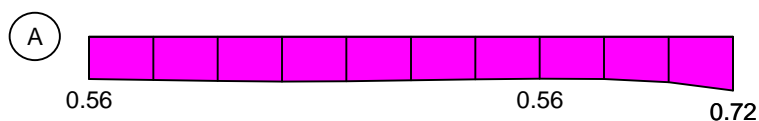
The ends of the beam are forked supported.



Max $M_{y,d} = 29.77 \text{ kNm}$, Min $M_{y,d} = -55.32 \text{ kNm}$



Max $V_{z,d} = 14.97 \text{ kN}$, Min $V_{z,d} = -31.43 \text{ kN}$



Maximum utilization = 0.72

Buckling load $N_{K_{i,z,d}}$

$$N_{K_{i,z,d}} = \pi^2 \cdot (E \cdot I_z / \gamma_M) / L^2$$

$$\text{with } I_z = 420.0 \text{ cm}^4 \quad E = 210000 \text{ N/mm}^2$$

$$L = 8.00 \text{ m} \quad \gamma_M = 1.1$$

$$N_{K_{i,z,d}} = 123.65 \text{ kN}$$

Ramification load factor $\eta_{K_{i,y}}$ for $M_{K_{i,y}}$

$$\eta_{K_{i,y}} = 1.97$$

Decisive check at location $x = 8.00 \text{ m}$
-----**Internal forces:**

$$N_d = 0.00 \text{ kN}$$

$$V_{z,d} = -31.43 \text{ kN}$$

$$M_{y,d} = -55.32 \text{ kNm}$$

Plastic internal forces:

$$N_{pl,k} = \pm 1101.60 \text{ kN} \quad N_{pl,d} = \pm 1001.45 \text{ kN}$$

$$V_{pl,z,k} = \pm 228.26 \text{ kN} \quad V_{pl,z,d} = \pm 207.51 \text{ kN}$$

$$M_{pl,y,k} = \pm 116.16 \text{ kNm} \quad M_{pl,y,d} = \pm 105.60 \text{ kNm}$$

Reduction factor κ_z

$$\bar{\lambda}_{k,z} = \sqrt{N_{pl,d} / N_{K_{i,z,d}}}$$

$$\text{with } N_{pl,d} = 1001.45 \text{ kN} \quad N_{K_{i,z,d}} = 123.65 \text{ kN}$$

$$\bar{\lambda}_{k,z} = 2.85 > 0,2$$

$$\kappa_z = 1 / (k + \sqrt{k^2 - \bar{\lambda}_{k,z}^2}) \quad k = 0,5 \cdot (1 + \alpha \cdot (\bar{\lambda}_{k,z} - 0,2) + \bar{\lambda}_{k,z}^2)$$

Buckling stress line b $\Rightarrow \alpha = 0.34$

$$k = 5.00$$

$$\kappa_z = 0.11$$

Buckling moment $M_{K_{i,y,d}}$

$$M_{K_{i,y,d}} = \frac{\eta_{K_{i,y}} \cdot M_{y,d}}{\gamma_M}$$

$$\text{with } \eta_{K_{i,y}} = 1.97 \quad M_{y,d} = -55.32 \text{ kNm} \quad \gamma_M = 1.1$$

$$M_{K_{i,y,d}} = -98.85 \text{ kNm}$$

Reduction factor κ_M

$$\bar{\lambda}_M = \sqrt{M_{pl,y,d} / M_{K_{i,y,d}}}$$

$$\text{with } M_{pl,y,d} = -105.60 \text{ kNm} \quad M_{K_{i,y,d}} = -98.85 \text{ kNm}$$

$$\bar{\lambda}_M = 1.03 > 0,4$$

$$\kappa_M = (1 / (1 + \bar{\lambda}_M^{-2n}))^{1/n}$$

Moment ratio $\psi = -0.19 \leq 0,5$

$$\text{Factor } K_n = 1.00$$

$$\text{Coefficient for hot rolled girder } n = 2.50 \Rightarrow n_{red} = n \cdot K_n = 2.50$$

$$\kappa_M = 0.73$$

Coefficient k_y

$$k_y = 1 - N_d / (\kappa_z \cdot N_{pl,d}) \cdot a_y \leq 1 \quad a_y = 0,15 \cdot \bar{\lambda}_{k,z} \cdot \beta_{M,y} - 0,15 \leq 0,9$$

$$\text{with } N_d = 0.00 \text{ kN} \quad N_{pl,d} = 1001.45 \text{ kN}$$

$$\kappa_z = 0.11 \quad \bar{\lambda}_{k,z} = 2.85$$

$$\text{Moment ratio } \psi_{y} = -0.19 \Rightarrow \beta_{M,y} = 1.59$$

$$a_y = 0.53$$

$$k_y = 1.00$$

Check

$$\frac{N_d}{\kappa_z \cdot N_{pl,d}} + \frac{M_{y,d}}{\kappa_M \cdot M_{pl,y,d}} \cdot k_y \leq 1$$

$$N_d = 0.00 \text{ kN}$$

$$M_{y,d} = -55.32 \text{ kNm}$$

$$N_{pl,d} = 1001.45 \text{ kN}$$

$$M_{pl,y,d} = -105.60 \text{ kNm}$$

$$\kappa_z = 0.11$$

$$\kappa_M = 0.73 \quad k_y = 1.00$$

$$0.00 + 0.72 = 0.72 \leq 1.0 \quad \text{The check is OK !}$$