

N, M_z



$$\eta = \frac{N_{Ed}}{N_{Rd}}$$

$$a = \frac{A - 2bt_f}{A}$$

$$M_{N,z,Rd} =$$

$$M_{pl,z,Rd} \quad \text{or} \quad N_{Ed} \leq a N_{Rd}$$

$$M_{pl,z,Rd} \left[1 - \left(\frac{\eta - a}{1 - a} \right)^2 \right]$$

Dimensionamento

$$N_{Ed} = 500 \text{ KN}$$

$$M_{Ed} = 700 \text{ KNm}$$

S355

Ni piece - dimension, per M

$$W_{pl} = \frac{M_{Ed} \gamma_{M0}}{f_y} = \frac{700 \times 10^6 \times 1.05}{355} = 2070 \times 10^3 \text{ mm}^3$$

IPE 500

$$W_{pl} = 2194 \times 10^3 \text{ mm}^3$$

$$A = 116 \times 10^2 \text{ mm}^2$$

$$N_{Rd} = A \frac{f_y}{\gamma_{m0}} = 116 \times 10^2 \times \frac{355}{1.05} \times 10^{-3} = 3922 \text{ kN}$$

$$\alpha = \frac{A - 2 b t_f}{A} = \frac{116 \times 10^2 - 2 \times 200 \times 16}{116 \times 10^2} = 0.448$$

$$\approx N_{ed} \leq \frac{\alpha}{2} N_{Rd}$$

$$M_{N,Rd} = M_{Rd}$$

$$500 \leq \frac{0.448}{2} \times 3922 = 879 \text{ kN} \quad \text{OK}$$

$$M_{Rd} = W_{pl} \frac{f_y}{\gamma_{m0}} = 2194 \times 10^3 \times \frac{355}{1.05} \times 10^{-6} = 741.8 \text{ kNm}$$

Dimensionnements

$$N_{Ed} = 400 \text{ KN}$$

$$M_{Ed} = 70 \text{ KNm}$$

S 355

$$A \geq \frac{N_{Ed} \gamma_m}{f_y} = \frac{400 \times 10^3 \times 1.05}{355} = 11.8 \times 10^2 \text{ mm}^2$$

$$W_{pl} \geq \frac{M_{Ed} \gamma_m}{f_y} = \frac{70 \times 10^6 \times 1.05}{355} = 207 \times 10^3 \text{ mm}^3$$

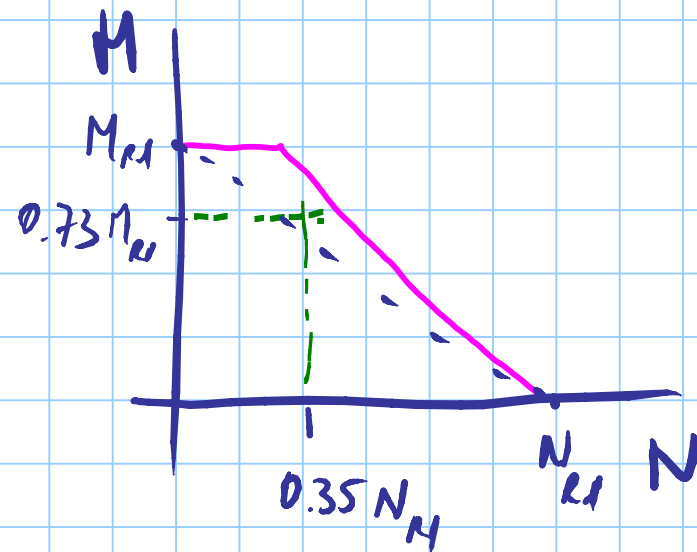
prova IPE 220

$$A = 33.4 \times 10^2 \text{ mm}^2$$

$$W_{pl} = 285.4 \times 10^3 \text{ mm}^3$$

$$\frac{A_{nec}}{A} = \frac{11.8}{33.4} = 0.35$$

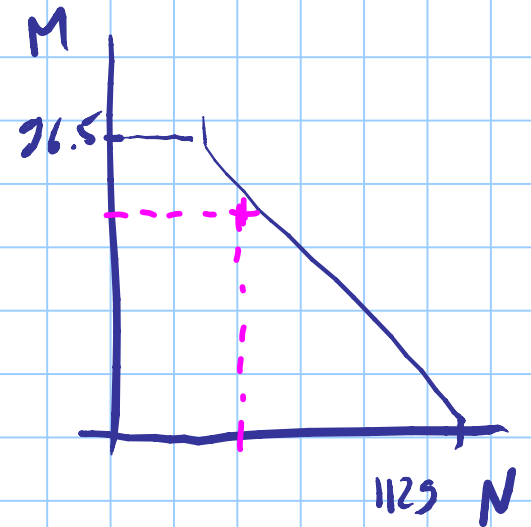
$$\frac{W_{pl,nec}}{W_{pl}} = \frac{207}{285.4} = 0.73$$



$$N_{Rd} = 33.4 \times 10^2 \times \frac{355}{1.05} \times 10^{-3} = 1129 \text{ kN}$$

$$M_{Rd} = 285.4 \times 10^3 \times \frac{355}{1.05} \times 10^{-6} = 96.5 \text{ kNm}$$

$$a = \frac{33.4 \times 10^2 - 2 \times 110 \times 9.2}{33.4 \times 10^2} = 0.394$$



$$\frac{a}{2} N_{Rd} = \frac{0.394}{2} \times 1129 = 222 \text{ kN}$$

$$N_{Ed} > \frac{a}{2} N_{Rd}$$

$$M_{N,Rd} = M_{Rd} \left[\frac{1-\eta}{1-0.5a} \right] = 96.5 \left[\frac{1-0.354}{1-0.197} \right] = 77.6 \text{ kNm}$$

$$\eta = \frac{400}{1129} = 0.354$$

Dimensions

$$N_{Ed} = 600 \text{ kN}$$

$$M_{z,Ed} = 40 \text{ kNm}$$

S 355

$$A_{MIN} = \frac{N_{Ed} \cdot \gamma_{M0}}{\gamma_y} = \frac{600 \cdot 1,05}{355} \cdot 10^3 = 17,74 \cdot 10^2 \text{ mm}^2$$

$$W_{pl,z} = \frac{M_{z,Ed} \cdot \gamma_{M0}}{\gamma_y} = \frac{40 \cdot 10^6 \cdot 1,05}{355} = 118,3 \cdot 10^3 \text{ mm}^3$$

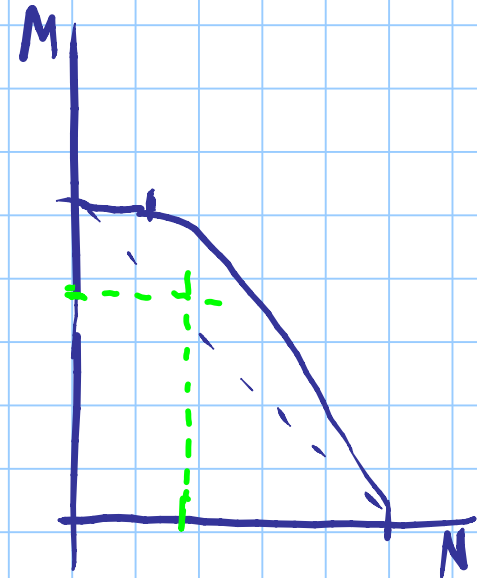
HE 180 A

$$A = 45,3 \cdot 10^2 \text{ mm}^2$$

$$W_{pl,t} = 156,5 \cdot 10^3 \text{ mm}^3$$

$$\frac{A_{NEC}}{A} = \frac{17,74}{45,3} = 0,39$$

$$\frac{W_{pl,NEC}}{W_{pl,t}} = \frac{118,3}{156,5} = 0,76$$



$$N_{R,d} = \frac{45,3 \times 10^2 \times 355}{1,05} \times 10^{-3} = 1531,6 \text{ KN}$$

$$M_{R,d,2} = \frac{156,5 \times 10^3 \times 355}{1,05} \times 10^{-6} = 52,9 \text{ KN}\cdot\text{m}$$

$$\alpha = \frac{A - 2 b t_f}{A} = \frac{45,3 \times 10^2 - 2 \times 180 \times 9,5}{45,3 \times 10^2} = 0,245$$

$$\alpha N_{R,d} = 0,245 \times 1531,6 = 375,3 \text{ KN}$$

$$M_{z,Rd} = M_{pl,Rd} \left[1 - \left(\frac{m-a}{1-a} \right)^2 \right] =$$

$$m = \frac{N_d}{N_{Rd}} = \frac{600}{1531} = 0,391$$

$$1 - \left(\frac{0,391 - 0,245}{1 - 0,245} \right)^2 = 0,96$$

$$M_{z,Rd} = 52,9 \times 0,96 = 50,9 \text{ KN}\cdot\text{m}$$