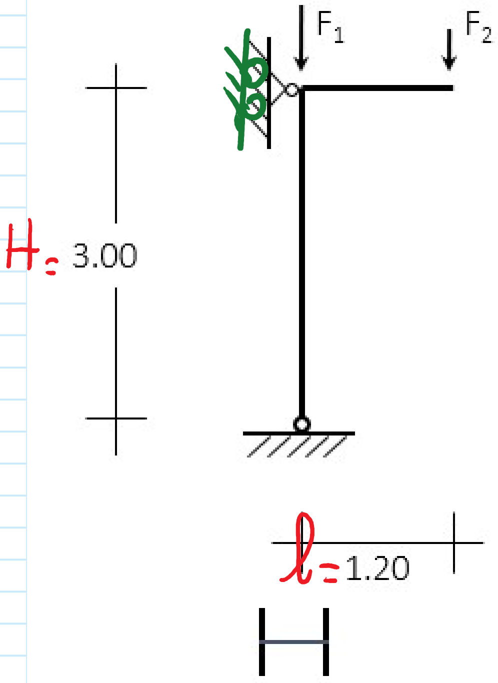



Sezione HEB200

Acciaio S235

Sezione di classe 1

$F_1 = 500$ kN
$F_2 = 80$ kN

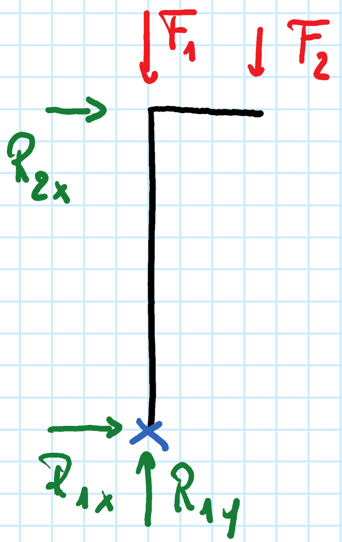
$A = 78{,}1\ cm^2$

$i_y = 8{,}54\ cm$

$i_z = 5{,}07\ cm$

$I_y = 5696\ cm^4$

$W_{pl,y} = 642{,}5\ cm^3$




Equilibrio alla rotazione attorno al punto ×

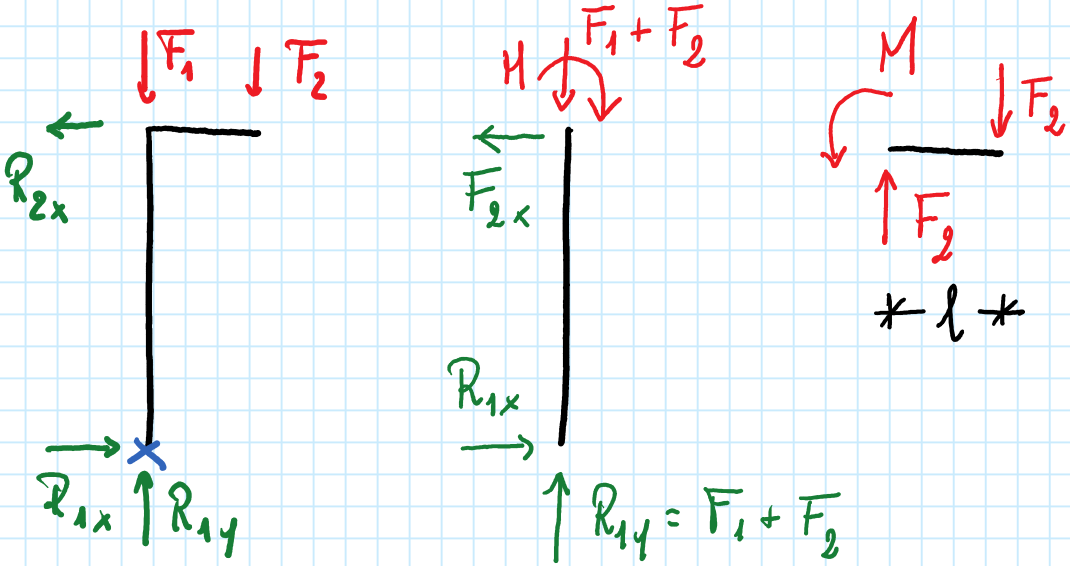
$$-R_{2x} H - F_2 l = 0 \Rightarrow R_{2x} = -F_2 \frac{l}{H} = -\frac{80}{3} \times 1{,}2 = -32 \text{ KN}$$

Equilibrio alla traslazione x

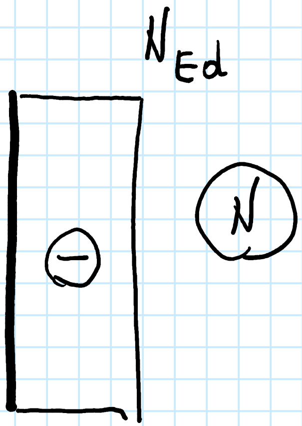
$$R_{1x} = -R_{2x} = 32 \text{ KN}$$

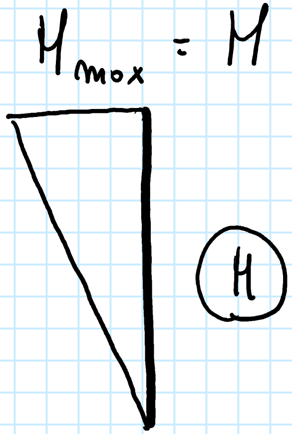
Equilibrio alla traslazione y

$$R_{1y} = F_1 + F_2 = 500 + 80 = 580 \text{ KN}$$




$$M = F_2 \ell = 80 \times 1{,}2 = 96{,}0 \text{ KNm}$$




$N_{Ed} = -R_{1y} = -580{,}0$ KN (compressione)

$M_{max} = 96{,}0$ KNm

L'asta è soggetta a presso-flessione retta e l'espressione di verifica diventa:

$$\frac{N_{Ed}}{N_{bRd}}+\frac{M_{y,eq,Ed}}{M_{y,Rd}\left(1-\frac{N_{Ed}}{N_{cr,y}}\right)}+\cancel{\frac{M_{z,eq,Ed}}{M_{z,Rd}\left(1-\frac{N_{Ed}}{N_{cr,z}}\right)}}^{\,0}\le 1$$

Il diagramma del momento è lineare con $M_a = M_{max}$ e $M_b = 0$

$$M_{y,eq,Ed} = 0{,}6\,M_a - \cancel{0{,}4\,M_b}^{\,0} = 0{,}6\,M_a > 0{,}4\,M_a$$

$$= 0{,}6 \times 96{,}0 = 57{,}6 \text{ kNm}$$

$$N_{b,Rd} = \chi_{min} \, A \, \frac{f_y}{\gamma_{M1}}$$

$A = 78{,}1 \ cm^2$

$i_y = 8{,}54 \ cm$

$i_z = 5{,}07 \ cm$

$$l_0 = l_{0y} = l_{0z} = H = 3{,}0 \ m$$

$$\lambda_y = \frac{l_{0y}}{i_y} = \frac{300}{8{,}54} = 35{,}1$$

$$\lambda_z = \frac{l_{0z}}{i_z} = \frac{300}{5{,}07} = 59{,}2 \xrightarrow{\text{snellezza massima}} N_{b,Rd}$$

$$\bar{\lambda}_z = \frac{\lambda_z}{\lambda_1} = \frac{59{,}2}{93{,}9} = 0{,}6304$$

$\lambda_1 = 93{,}9 \quad (S235)$

$$\phi_z = \frac{1}{2}\left[1 + \alpha\left(\bar{\lambda}_z - 0{,}2\right) + \bar{\lambda}_z^2\right]$$

Curve e $\longrightarrow$ $\alpha = 0{,}49$

$$\phi_z = \frac{1}{2}\left[1 + 0{,}49 \times \left(0{,}6304 - 0{,}2\right) + 0{,}6304^2\right] = 0{,}8041$$

$$\chi_z = \chi_{min} = \frac{1}{\phi_z + \sqrt{\phi_z^2 - \bar{\lambda}_z^2}} = \frac{1}{0{,}8041 + \sqrt{0{,}8041^2 - 0{,}6304^2}}$$

$$= 0{,}7672$$

$$N_{b,Rd} = 0{,}7672 \times 78{,}1 \times \frac{235}{1{,}05} \times \frac{1}{10} = 1341{,}0 \ kN$$

$$N_{cr,y} = \frac{\pi^2 E_s I_y}{l_0^2} = \frac{3{,}14^2 \times 210\,000 \times 5696}{300^2} \times \frac{\cancel{10}^2}{10^{\cancel{3}}}$$

$$= 13104 \text{ KN}$$

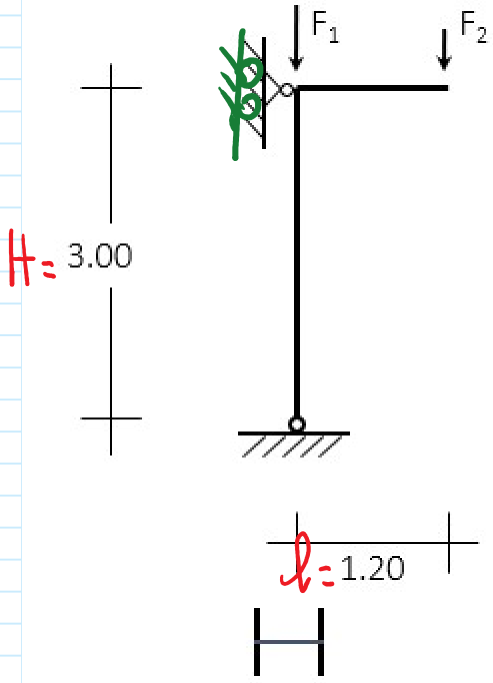
$$I_y = 5696 \text{ cm}^4$$

$$M_{y,Rd} = M_{pl,y,Rd} = W_{pl,y} \frac{f_y}{\gamma_{M1}} = 642{,}5 \times \frac{235}{1{,}05} \times \frac{1}{10^3} = 143{,}8 \text{ KNm}$$

Infine eseguo le verifiche...

$$\frac{580}{1341} + \frac{57{,}6}{143{,}8 \times \left(1 - \frac{580}{13104}\right)} = 0{,}4325 + 0{,}4191 = 0{,}8516 < 1$$

OK!




| | |
|---|---|
| Sezione | HEB200 |
| Acciaio | S235 |

Sezione di classe 1

$F_1 = 500$ kN
$F_2 = 80$ kN

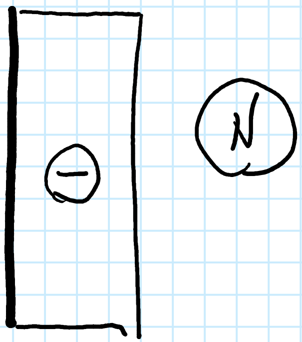
$A = 78{,}1 \text{ cm}^2$

$i_y = 8{,}54 \text{ cm}$

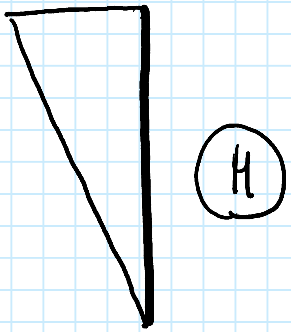
$i_z = 5{,}07 \text{ cm}$

$W_{pl,y} = 642{,}5 \text{ cm}^3$

$N_{Ed}$




$M_{Ed} = M_{max}$




$N_{Ed} = -580{,}0 \text{ kN}$

$M_{Ed} = 96{,}0 \text{ kN}$

$$\frac{N_{Ed}}{N_{b,y,Rd}} + k_{yy}\frac{M_{y,Ed}}{M_{y,Rd}} + k_{yz}\frac{\cancel{M_{z,Ed}}^{\,0}}{M_{z,Rd}} \leq 1$$

$$\frac{N_{Ed}}{N_{b,z,Rd}} + k_{zy}\frac{\cancel{M_{y,Ed}}^{\,0}}{M_{y,Rd}} + k_{zz}\frac{\cancel{M_{z,Ed}}^{\,0}}{M_{z,Rd}} \leq 1$$

$$N_{b,y,Rd} = \chi_y \, A \frac{f_y}{\gamma_{M1}} = 0{,}9362 \times 78{,}1 \times \frac{235}{1{,}05} \times \frac{1}{10} = 1636{,}4 \text{ kN}$$

$$\lambda_y = \frac{l_{0y}}{i_y} = \frac{300}{8{,}54} = 35{,}12$$

$$\bar{\lambda}_y = \frac{\lambda_y}{\lambda_1} = \frac{35{,}12}{93{,}9} = 0{,}3740$$

Curva b $\rightarrow$ $\alpha = 0{,}34$

$$\phi_y = \frac{1}{2}\left[1 + \alpha(\bar{\lambda}_y - 0{,}2) + \bar{\lambda}_y^2\right] = \frac{1}{2}\left[1 + 0{,}34(0{,}3740 - 0{,}2) + 0{,}3740^2\right] = 0{,}5995$$

$$\chi_y = \frac{1}{\phi_y + \sqrt{\phi_y^2 - \bar{\lambda}_y^2}} = \frac{1}{0{,}5995 + \sqrt{0{,}5995^2 - 0{,}3740^2}} = 0{,}9362$$

$$N_{b,z,Rd} = 1341,0 \text{ KN}$$

$$M_{y,Rd} = M_{pl,y,Rd} = W_{pl,y} \frac{f_y}{\gamma_{M1}} = 143,8 \text{ KNm}$$

$$k_{yy} = C_{my}\left(1+\left(\bar{\lambda}_y - 0.2\right)\frac{N_{Ed}}{N_{b,Rd,y}}\right) \le C_{my}\left(1+0.8\frac{N_{Ed}}{N_{b,Rd,y}}\right) = 0,6 \times \left[1 + \overbrace{(0,3740 - 0,2)}^{0,1740 \,<\, 0.8} \times \frac{580}{1636,4}\right]$$

$$= 0,637$$

$$C_{my} = 0,6 + 0,4\,\psi \geq 0,4 \implies C_{my} = 0,6 + 0,4 \times 0 = \underline{0,6} > 0,4$$

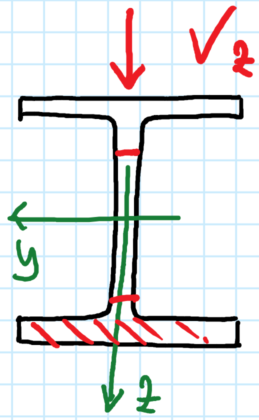

$$\psi = \frac{0}{M} = 0$$

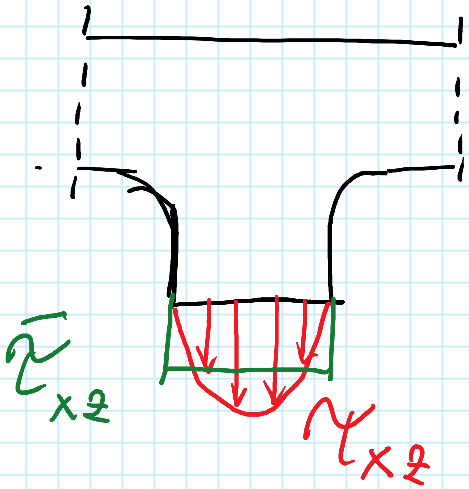
$$\frac{580}{1636{,}4} + 0{,}637\,\frac{96{,}0}{143{,}8} = 0{,}3544 + 0{,}4252 = 0{,}7796 \leq 1$$

OK!

$$\frac{580}{1341} = 0{,}4325 \leq 1$$

# Taglio




Formule di Jourawsky

$$\tau_{xz} = \frac{V_z S_y}{I_y b}$$

Stiamo assumendo

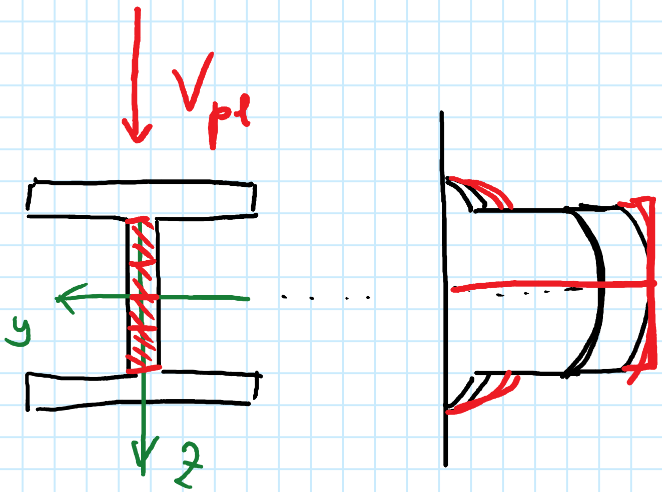
$$\tau_{xz} = \bar{\tau}_{xz}$$

$V_z$: Taglio agente

$I_y$: Momento d'inerzia dell'intera sezione rispetto a $y$

$b$: lunghezza della corda

$S_y$: Momento statico rispetto ad $y$ della "parte di sezione sotto (o sopra) la corda"




$\tau_{max} = \dfrac{f_y}{\sqrt{3}}$

Non posso utilizzarla quando la sezione si plasticizza

$$\cancel{\tau_{xz} = \frac{V_z S_y}{I_y b}}$$

$$\sigma_{id} = \sqrt{\sigma^2 + 3\tau^2} = \sqrt{0 + 3\tau_{max}^2} = \underbrace{\sqrt{3}\,\tau_{max} = f_y}_{\text{Limite elastico}}$$

$$\tau_{max} = \tau_y = \frac{f_y}{\sqrt{3}}$$

Oltre il limite elastico...

$V_{pl} = t_w h_w \dfrac{f_y}{\sqrt{3}}$ taglio che produce la plasticizzazione di tutta l'anima.