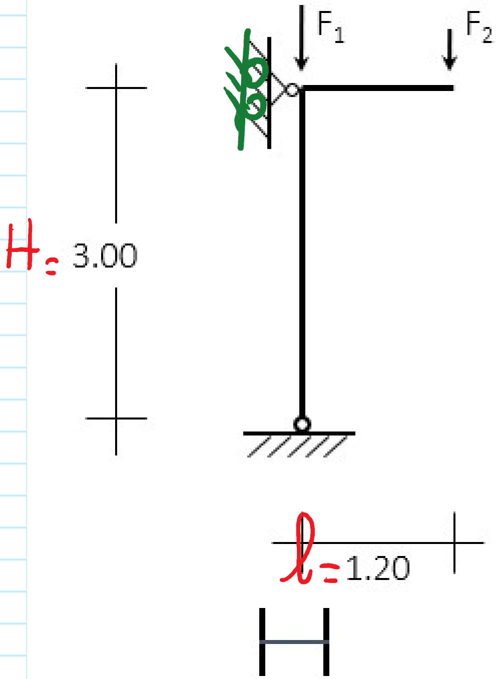


Sezione	HEB200
Acciaio	S235

Sezione di classe 1

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

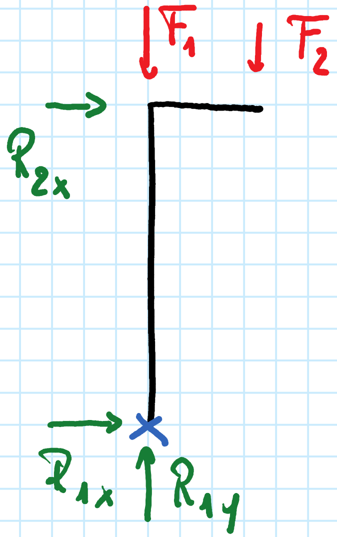
$A = 78,1\ cm^2$

$i_y = 8,54\ cm$

$i_z = 5,07\ cm$

$I_y = 5696\ cm^4$

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



Equilibrio alla rotazione attorno al punto ×

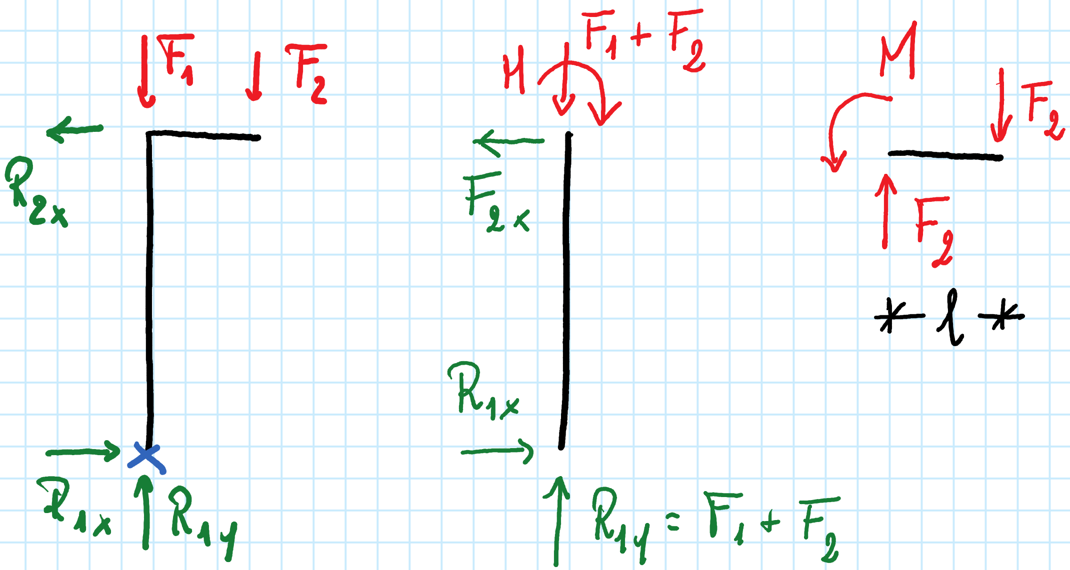
$$-R_{2x} H - F_2 l = 0 \Rightarrow R_{2x} = -F_2 \frac{l}{H} = -\frac{80}{3} \times 1,2 = -32\ KN$$

Equilibrio alla traslazione x

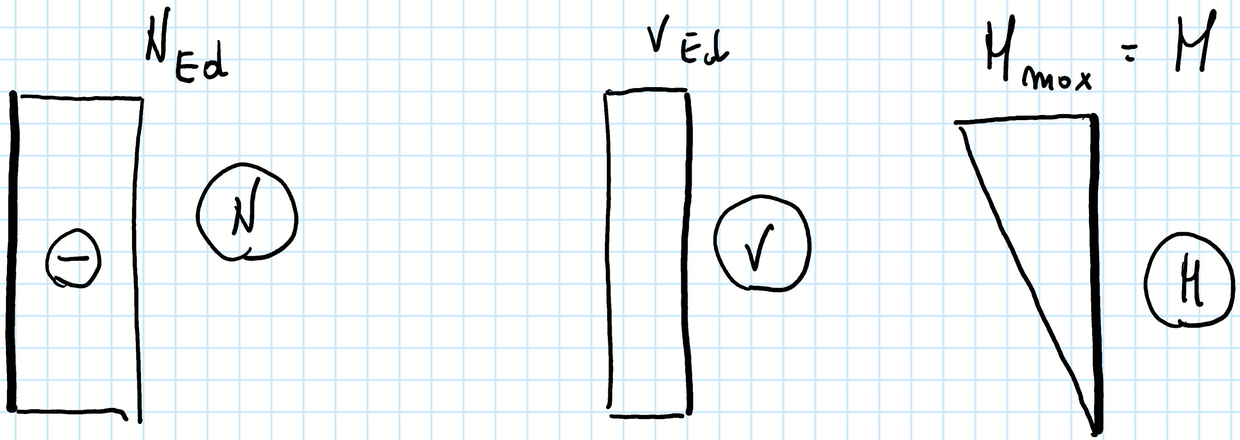
$$R_{1x} = -R_{2x} = 32\ KN$$

Equilibrio alla traslazione y

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



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



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

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

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

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

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

$$\lambda_y = \frac{l_{0y}}{i_y} = \frac{300}{8{,}54} = 35{,}12 \qquad \lambda_1 = 93{,}9 \quad (S235)$$

$$\bar{\lambda}_y = \frac{\lambda_y}{\lambda_1} = \frac{35{,}12}{93{,}9} = 0{,}3740 \qquad \text{Curva } b \rightarrow \alpha = 0{,}34$$

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

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

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

$$\lambda_z = \frac{l_{0z}}{i_z} = \frac{300}{5{,}07} = 59{,}2$$

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

Curva c $\longrightarrow$ $\alpha = 0{,}49$

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

$$\chi_z = \frac{1}{\phi_z + \sqrt{\phi_z^2 - \bar{\lambda}_z^2}} = \frac{1}{0{,}8041 + \sqrt{0{,}8041^2 - 0{,}6304^2}} = 0{,}7672$$

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

$$M_{y,Rd} = M_{pl,y,Rd} = W_{pl,y}\,\frac{f_y}{\gamma_{M1}} = 642.5 \times \frac{235}{1{,}05} \times \frac{1}{10^3} = 143.8 \text{ kNm}$$

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

$$= 0{,}637$$

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

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

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

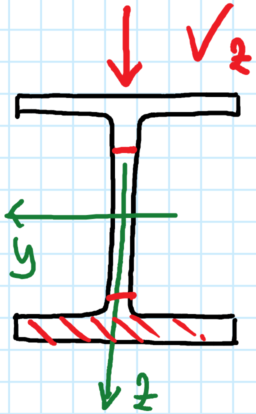
$$\frac{N_{Ed}}{N_{b,z,Rd}} + \cancel{k_{zy}\frac{M_{y,Ed}}{M_{y,Rd}}}^{0} + k_{zz}\cancel{\frac{M_{z,Ed}}{M_{z,Rd}}}^{0} \leq 1$$

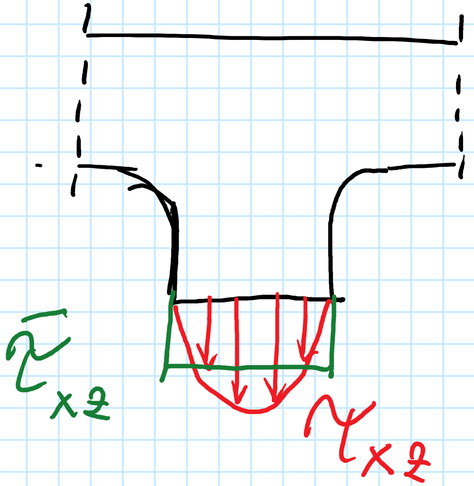
$$\frac{580}{1636,8} + 0,6369 \times \frac{96,0}{143,8} = 0,3543 + 0,4252 = 0,7795 < 1$$

$$\frac{580}{1341,6} = 0,4323 < 1$$

OK!

Taglio





Formule di Jourawsky

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

Stiamo assumendo

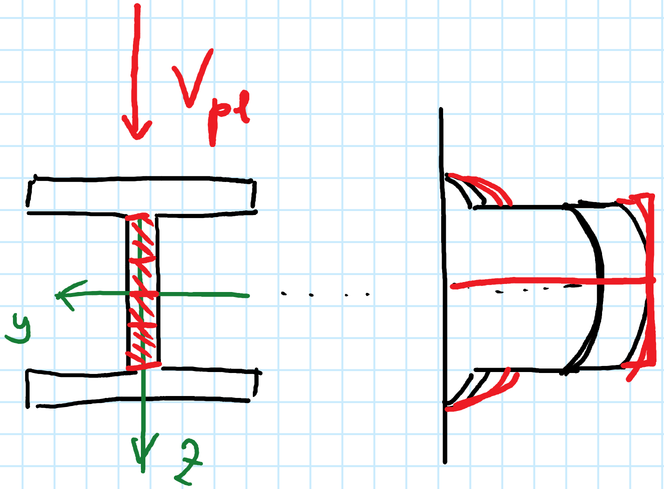
$$\tau_{xz} = \bar{\tau}_{xz}$$

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"



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

Non posso utilizzarla quando la sezione si plasticizza

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

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

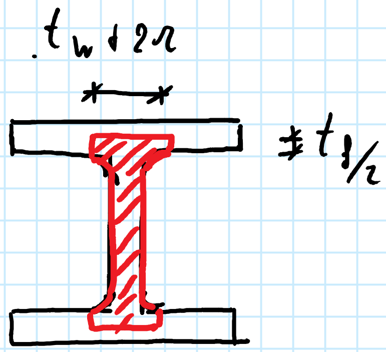
$$\tau_{max} = \tau_y = \frac{f_y}{\sqrt{3}}$$

Oltre il limite elastico...

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

Formule delle NTC18 per il calcolo della resistenza a taglio di sezioni a doppio T sollecitate nel piano dell'anima

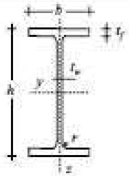
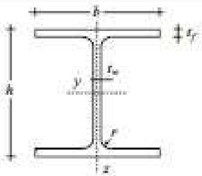
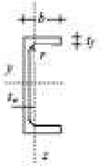
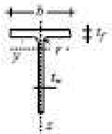
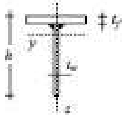
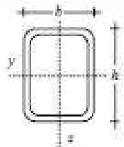
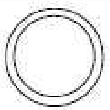
$$V_{c,Rd} = V_{pl,Rd} = \frac{A_v \, f_y}{\sqrt{3} \, \gamma_{M0}}$$



A_v = area resistente a taglio

$$A_v = A - 2bt_f + (t_w + 2r)t_f$$

Le formule per il calcolo di $V_{c,Rd}$ è valida anche per altri tipi di sezione ma cambia il calcolo di A_v

	Forma della sezione	Direzione di V	A_V
Profilati ad I o H		z-z (anima)	$A-2bt_f+(t_w+2r)t_f$
		y-y (ali)	$A-\sum(h_w t_w)$
Profilati a C o U		z-z (anima)	$A-2bt_f+(t_w+r)t_f$
Profilati a T		z-z (anima)	$A-bt_f+(t_w+2r)\frac{t_f}{2}$ (EC3) $0.9(A-bt_f)$ (NTC08)
Sezioni saldate a T		z-z (anima)	$t_w\left(h-\frac{t_f}{2}\right)$
Scatolari		z-z (anime)	$\frac{Ah}{b+h}$
		y-y (basi)	$\frac{Ab}{b+h}$
Tubolari		--	$\frac{2A}{\pi}$

A = area nominale della sezione trasversale

In sintesi...

1. Se ho A_v + classi 1 e 2

$$V_{Ed} \le V_{c,Rd} = V_{pl,Rd} = \frac{A_v f_y}{\sqrt{3}\,\gamma_{M0}}$$

2. altrimenti (verifica elastica) o classe 3

Calcolo τ_{max} con Jourawsky

$$\tau_{max} \le \frac{f_y}{\sqrt{3}\,\gamma_{M0}}$$