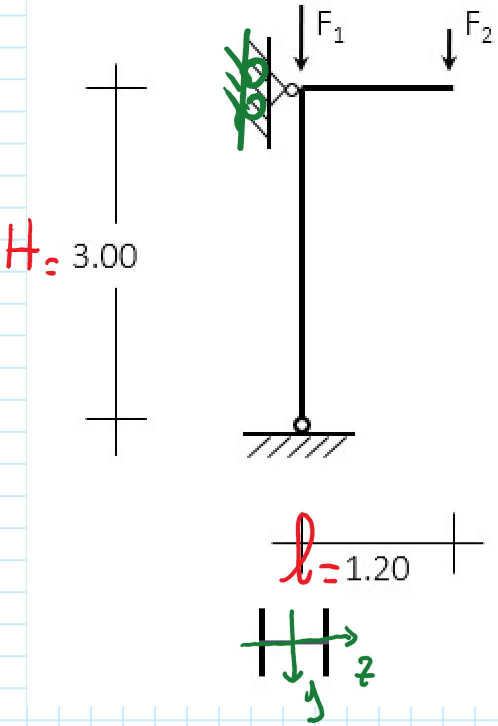


Sezione	HEB200
Acciaio	S235

Sezione di classe 1

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

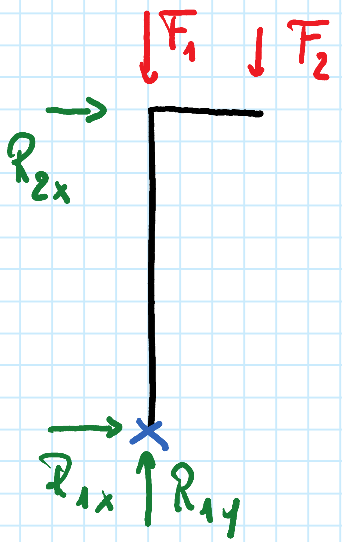
$A = 78{,}1\ cm^2$

$i_y = 8{,}54\ cm$

$i_z = 5{,}07\ cm$

$I_y = 5696\ cm^4$

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



Equilibrio alla rotazione attorno al punto ×

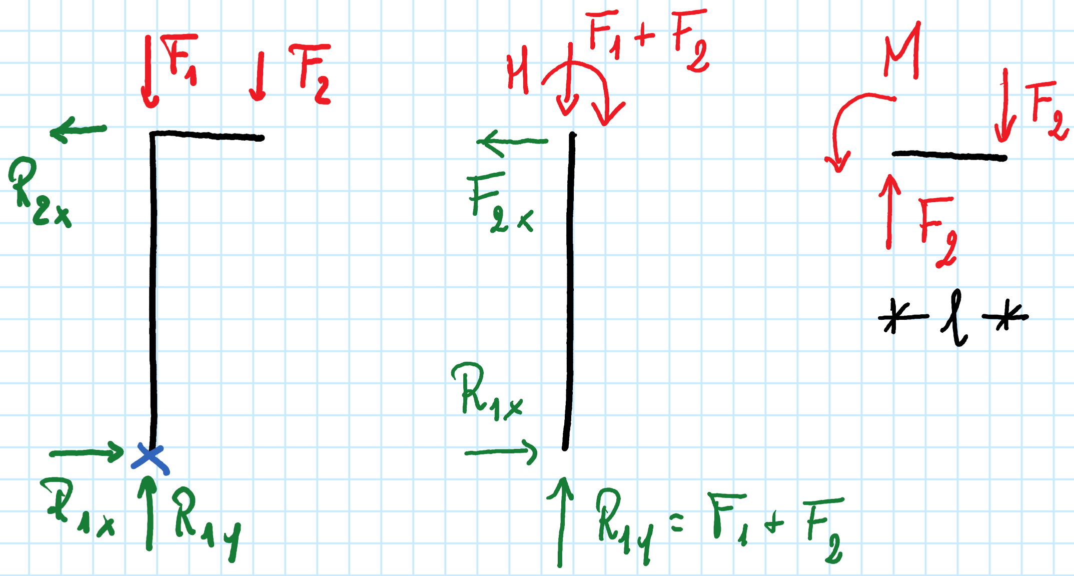
$$-R_{2x} H - F_2 l = 0 \Rightarrow R_{2x} = -F_2 \frac{l}{H} = -\frac{80}{3} \times 1{,}2 = -32\ KN$$

Equilibrio alla traslazione x

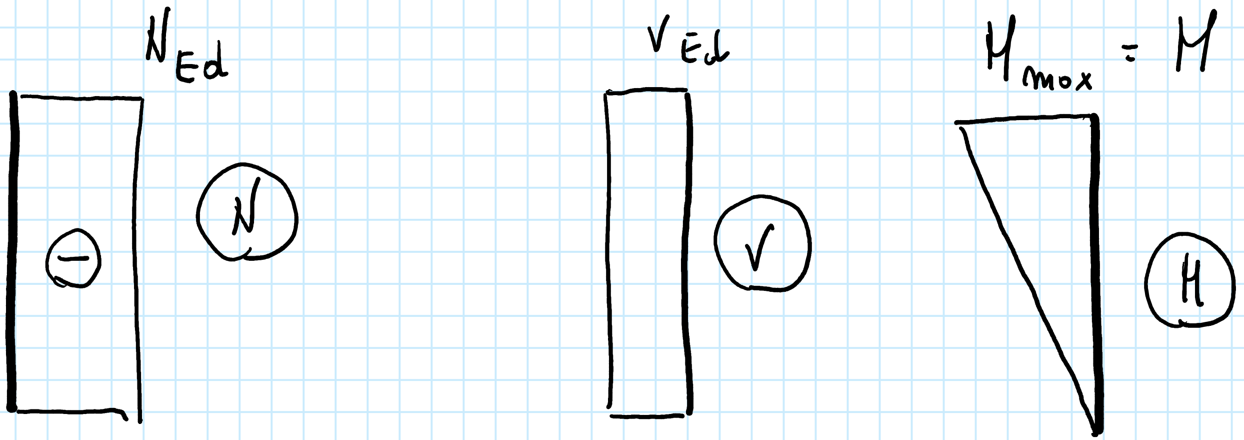
$$R_{1x} = -R_{2x} = 32\ KN$$

Equilibrio alla traslazione y

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

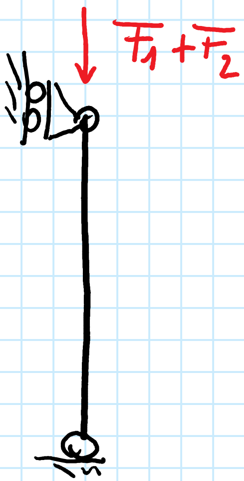


$$M = F_2 \, l = 80 \times 1{,}2 = 96{,}0 \text{ KNm}$$

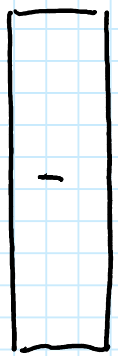


$$N_{Ed} = -R_{1y} = -580{,}0 \text{ KN} \quad (\text{compressione})$$

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



N



$N = -(F_1+F_2)$

$= -580\ KN$

M

$M_{max} = F_2\, l = 80 \times 1{,}2$

$= 96{,}0\ KN/m$

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

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

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

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

Profilo =	HEB 200		Acciaio =	S235	f_{yk} =	235	MPa		
Doppio profilo	NO		GammaM1=	1.05	f_{uk} =	360	MPa		
Distanza =		cm			E_s =	210000	MPa		
Area =	78.1	cm^2							
ρ_y =	8.54	cm	l_{oy} =	300.0	cm	λ_y =	35.1		
ρ_z =	5.06	cm	l_{oz} =	300.0	cm	λ_z =	59.2	$\lambda_{z\ eq}$ =	
$\rho_{min\ SP}$ =		cm	$l_{o\ SP}$ =	75.0	cm	$\lambda_{min\ SP}$ =			
Curva =	b	α_y =	0.34	$N_{cr,y}$ =	13104.1	kN	λ_{Sy} =	0.3742	
Curva =	c	α_z =	0.49	$N_{cr,z}$ =	4608.0	kN	λ_{Sz} =	0.6311	
ϕ_y =	0.5997	χ_y =	0.9362	$N_{b,Rd,y}$ =	1636.38	kN			
ϕ_z =	0.8048	χ_z =	0.7668	$N_{b,Rd,z}$ =	1340.33	kN			
		χ_{min} =	0.7668	$N_{b,Rd}$ =	1340.33	kN			

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

$$k_{yy} = C_{my}\left(1+\left(\bar{\lambda}_y - 0.2\right)\frac{N_{Ed}}{N_{b,Rd,y}}\right) \leq C_{my}\left(1+0.8\frac{N_{Ed}}{N_{b,Rd,y}}\right)$$

$$= 0{,}6 \times \left[1 + (0{,}3742 - 0{,}2) \times \frac{580}{1636{,}4}\right] = \underline{\underline{0{,}6370}}$$

$$\leq 0{,}6 \times \left(1 + 0{,}8 \times \frac{580}{1636.4}\right) = \cancel{0{,}7701}$$

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

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

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

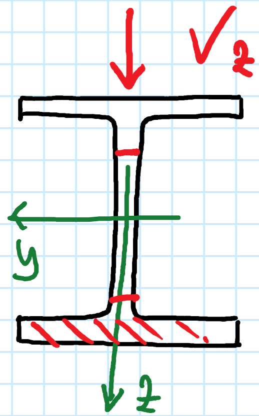
$$\frac{N_{Ed}}{N_{b,z,Rd}} + \cancel{k_{zy}\frac{M_{y,Ed}}{M_{y,Rd}}}^{0} + k_{zz}\cancel{\frac{M_{z,Ed}}{M_{z,Rd}}}^{0} \leq 1$$

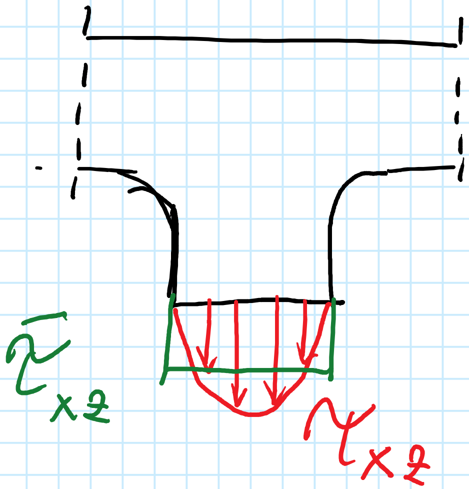
$$\frac{580}{1636,8} + 0,6370 \times \frac{96,0}{143,8} = 0,3543 + 0,4253 = 0,7796 < 1$$

$$\frac{580}{1841,6} = 0,4323 < 1$$

OK!

Taglio





Formule di Jourawsky

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

Stiamo assumendo

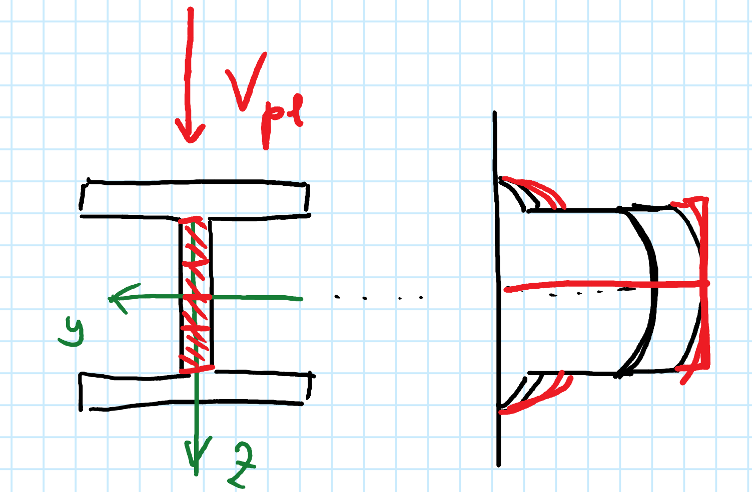
$$\tau_{xz} = \bar{\tau}_{xz}$$

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

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

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

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

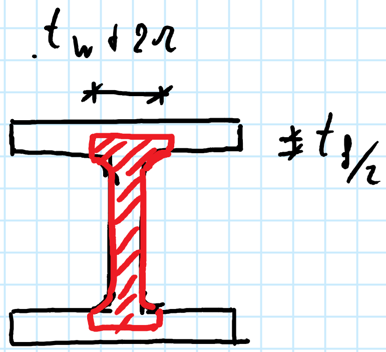
Oltre il limite elastico...

$$V_{pl} = t_w h_w \frac{f_y}{\sqrt{3}}$$

taglio che produce la plasticizzazione di tutta l'anima.

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

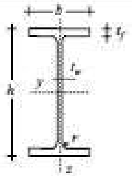
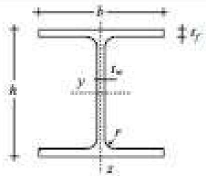
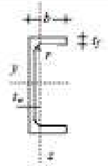
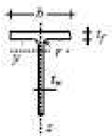
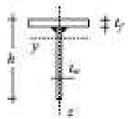
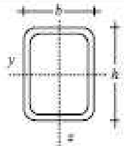
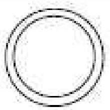
$$V_{c,Rd} = V_{pl,Rd} = \frac{A_v f_y}{\sqrt{3}\,\gamma_{M0}}$$



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...

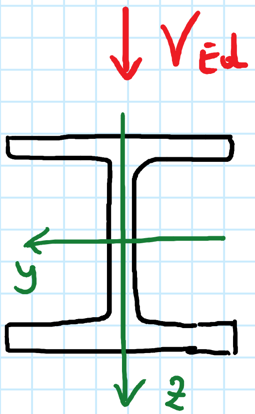
1. Se ho A_v + classe 1 e 2

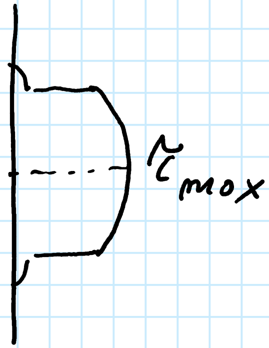
$$V_{Ed} \le V_{c,Rd} = V_{pl,Rd} = \frac{A_v f_y}{\sqrt{3}\,\gamma_{M0}}$$

2. altrimenti (verifica elastica) o classe 3

Calcolo τ_{max} con Jourawsky

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





IPE 270

S 235

$V_{Ed} = 200\ kN$

Comportamento elastico (classe 3)

1. $$\tau_{max} = \frac{V_{Ed}\, S_y}{I_y\, b}$$

$b = t_w \;;\; S_y = \dfrac{W_{pl,y}}{2}$

2. $$\tau_{max} \leq \frac{f_y}{\sqrt{3}\, \gamma_{M0}}$$

	G kg/m	h mm	b mm	t_w mm	t_f mm	r mm	A cm^2	h_i mm	d mm	∅	p_{min} mm	p_{max} mm	A_L m^2/m	A_G m^2/t
IPE A 270•	30.7	267	135	5.5	8.7	15	39.15	249.6	219.6	M16	70	72	1.037	33.75
IPE 270	36.1	270	135	6.6	10.2	15	45.95	249.6	219.6	M16	72	72	1.041	28.86

	G kg/m	I_y cm^4	$W_{el.y}$ cm^3	$W_{pl.y}$♦ cm^3	i_y cm	A_{vz} cm^2	I_z cm^4	$W_{el.z}$ cm^3	$W_{pl.z}$♦ cm^3	i_z cm	s_s mm	I_t cm^4	$I_w \times 10^{-3}$ cm^6	S 235	S 355	S 460	S 235	S 355	S 460
IPE A 270	30.7	4917	368.3	412.5	11.21	18.75	358.0	53.03	82.34	3.02	40.47	10.30	59.51	1	1	-	3	4	-
IPE 270	36.1	5790	428.9	484.0	11.23	22.14	419.9	62.20	96.95	3.02	44.57	15.94	70.58	1	1	-	2	3	-

$b = t_w = 6.6\ mm$

$I_y : 5790\ cm^4$

$S_y : \frac{W_{pl,y}}{2} : \frac{484}{2} = 242\ cm^3$

$\tau_{max} = \frac{200 \times 242}{5790 \times 6,6} \times \frac{\cancel{10^3}^{2} \times \cancel{10^3}}{\cancel{10^4}} = 126,7\ MPa$

$\tau_{max} : 126,7\ MPa \le \frac{f_y}{\sqrt{3}\gamma_{M0}} : \frac{235}{\sqrt{3} \times 1,05} = 129,2\ MPa$

OK!