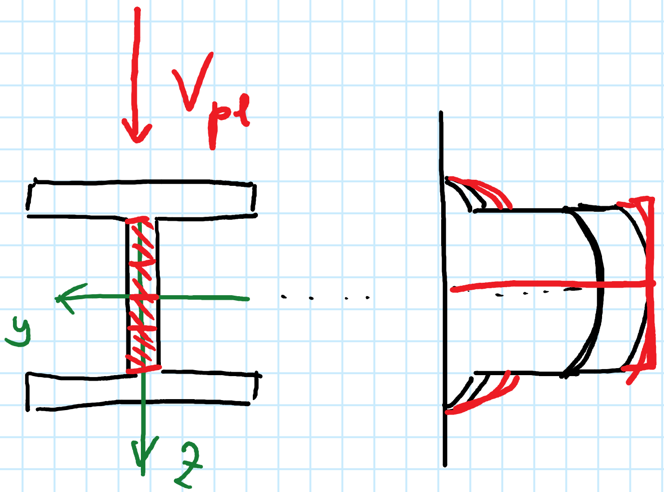


$\tau_{max} = \frac{f_y}{\sqrt{3}}$

Non posso utilizzarla quando la sezione si plasticizza

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

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

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

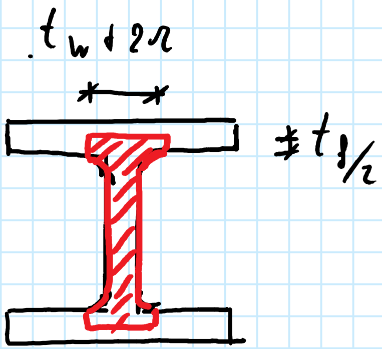
Oltre il limite elastico...

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

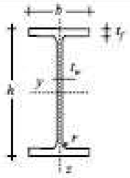
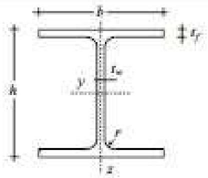
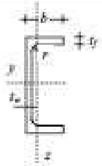
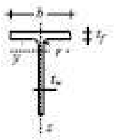
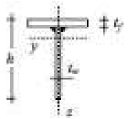
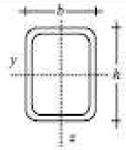
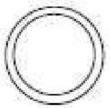
$$V_{c,Rd} = V_{pl,Rd} = \frac{A_v f_y}{\sqrt{3}\,\gamma_{M0}}$$

A_v = area resistente a taglio



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

La formula 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...

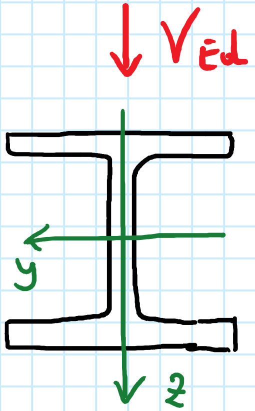
1. Se ho A_v + classe 1 e 2

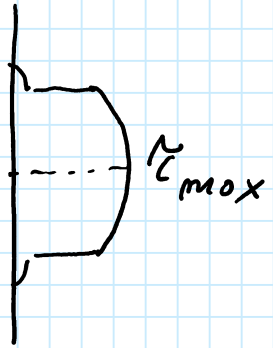
$$V_{Ed} \le V_{c,Rd} = V_{pl,Rd} = \frac{A_v f_y}{\sqrt{3}\,\gamma_{M0}}$$

2. altrimenti (verifica elastica) o classe 3

calcolo τ_{max} con Jourawski

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





IPE 270

S 235

$V_{Ed} = 200 \text{ kN}$

Comportamento elastico
(classe 3)

$t_w = 6.6 \text{ mm}$

$W_{pl,y} = 484 \text{ cm}^3$

$I_y = 5790 \text{ cm}^4$

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

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

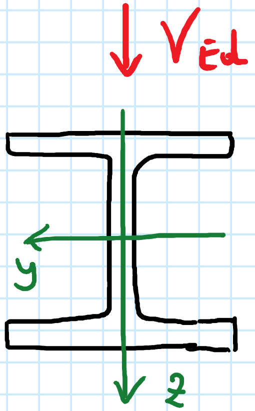
2. $\tau_{max} \leq \dfrac{f_y}{\sqrt{3}\,\gamma_{M0}}$

$$S_y = \frac{484}{2} = 242 \ cm^3$$

$$\tau_{max} = \frac{200 \times 242}{5790 \times 0,66} \times \frac{\cancel{10^3}}{\cancel{10^2}} = 126,6 \ MPa$$

$$\tau_{max} = 126,6 \leq \frac{f_y}{\sqrt{3}\,\gamma_{M0}} = \frac{235}{\sqrt{3} \times 1,05} = 129,2 \ MPa$$

OK!



IPE 270

S 235

$V_{Ed} = 200$ kN

Comportamento plastico

(classe 1 o 2)

$b = 135$ mm

$t_w = 6{,}6$ mm

$t_f = 10{,}2$ mm

$r = 15$ mm

$A = 45{,}95$ cm^2

$$V_{Ed} \leq V_{c,Rd}$$

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

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

$$A_V = 45{,}95 - 2 \times \frac{135 \times 10{,}2}{10^2} + \frac{(6{,}6 + 2 \times 15) \times 10{,}2}{10^2} = 22{,}14 \text{ cm}^2$$

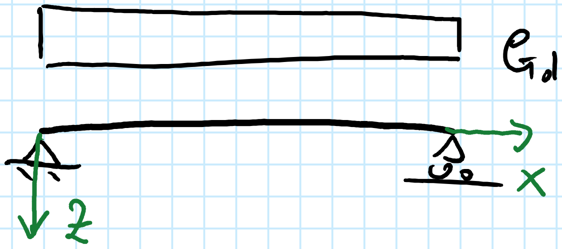
$$V_{c,Rd} = \frac{22{,}14 \times 235}{\sqrt{3} \times 1{,}05} \times \frac{\cancel{10^2}}{10^3} = 286{,}1 \text{ KN}$$

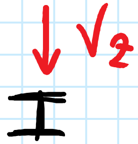
$$V_{Ed} = 200 \text{ KN} \leq V_{c,Rd} = 286{,}1 \text{ KN}$$

OK!

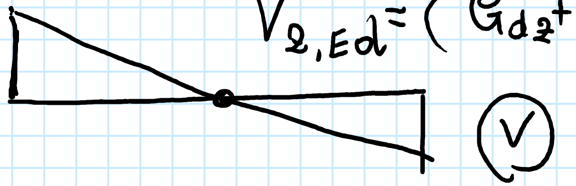
Progetto delle coperture in acciaio

Verifica a taglio (SLU) delle travi secondarie





$$V_{z,Ed} = (G_{dz} + Q_{dz}) \frac{L}{2}$$



$$V_{z,Ed} = (G_{dz} + Q_{dz}) \frac{L}{2} = (0{,}47 + 1{,}83) \times \frac{5{,}8}{2} = 6{,}67 \text{ KN}$$

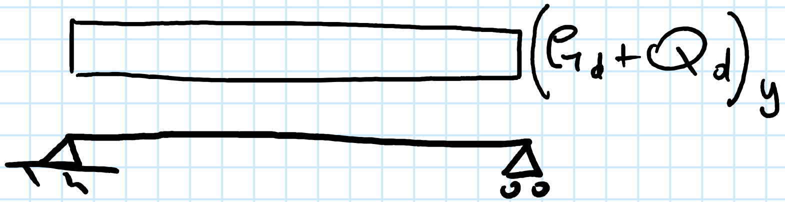
(G_{dz} e Q_{dz}: vedi lezione del 4/12/2023)

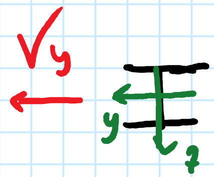
$$V_{c,z,Rd} = \frac{A_{vz} f_y}{\sqrt{3}\, \gamma_{M0}} = \frac{8{,}42 \times 235}{\sqrt{3} \times 1{,}05} \times \frac{1}{10} = 108{,}8 \text{ KN}$$

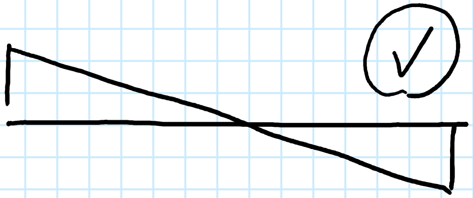
$$A_{vz} = A - 2 b t_f + (t_w + 2r) t_f = 25{,}3 - 2 \times 12 \times 0{,}8 + (0{,}5 + 2 \times 1{,}2) \times 0{,}8$$
$$= 8{,}42 \text{ cm}^2$$

$$V_{z,Ed} = 6{,}67 \ll V_{c,Rd} = 108{,}8 \text{ KN}$$

OK!







$$V_{y,Ed} = (G_{dy}+Q_{dy})\frac{L}{2}$$

$$V_{y,Ed} = (G_{dy}+Q_{dy})\frac{L}{2} = (0{,}09+0{,}33)\times\frac{5{,}8}{2} = 1{,}2 \text{ KN}$$

(G_{dy} e Q_{dy}: vedi lezione del 4/12/2023)

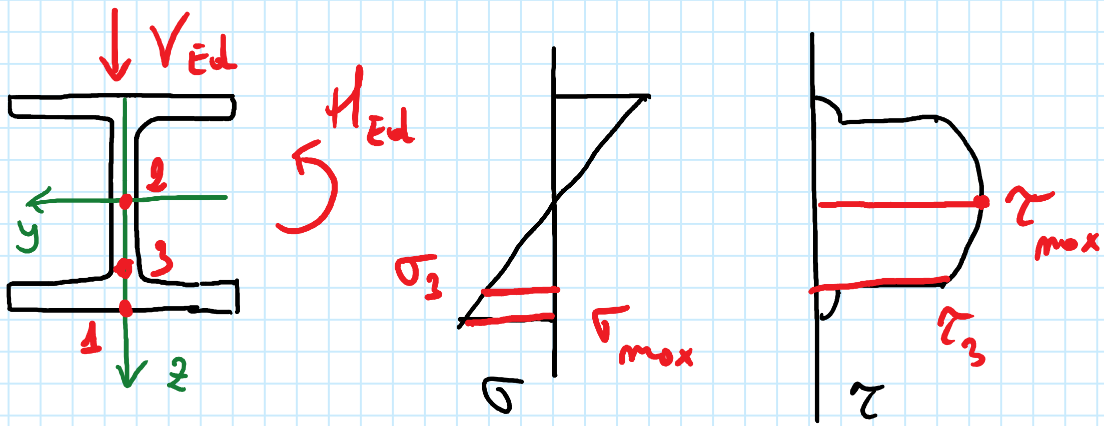
$$V_{e,y,Rd} = \frac{A_{vy} f_y}{\sqrt{3}\,\gamma_{M0}} = \frac{20{,}4\times 235}{\sqrt{3}\times 1{,}05}\times\frac{1}{10} = 263{,}6 \text{ KN}$$

$$A_{vy} = A - h_w t_w = 25{,}3-(11{,}4-2\times 0{,}8)\times 0{,}5 = 20{,}4 \text{ cm}^2$$

$$V_{y,Ed} = 1{,}2 \text{ KN} \ll V_{e,Rd} = 263{,}6 \text{ KN}$$

OK!

Flessione e taglio



Comportamento elastico

Classe 3

Le tensioni nel generico punto si calcolano con Navier

$$\sigma = \frac{M_{Ed}}{I_y} z$$

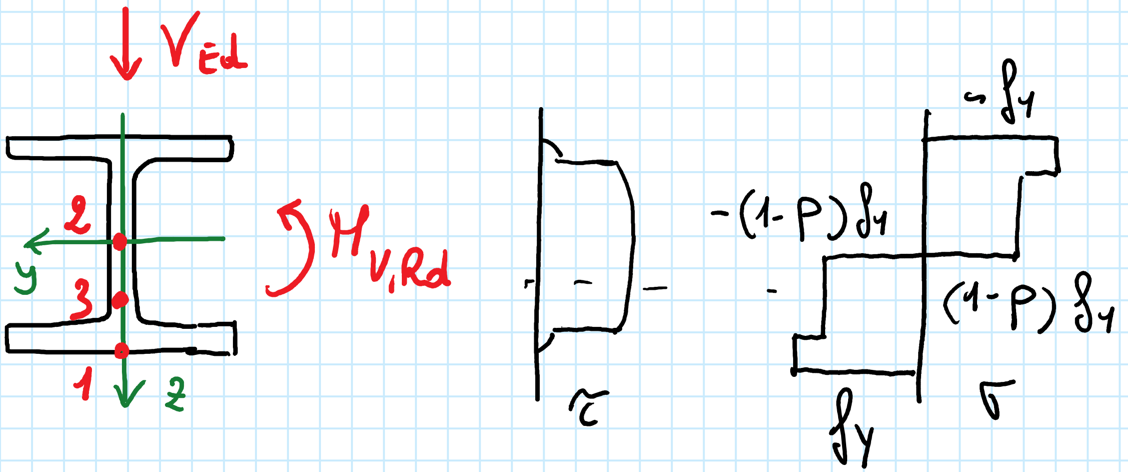
e Jourawsky

$$\tau = \frac{V_{Ed}\, S_y}{I_y\, b}$$

1. $\sigma_1 \leq f_y / \gamma_{M0}$

2. $\tau_2 \leq \dfrac{f_y}{\sqrt{3}\,\gamma_{M0}}$

3. $\sigma_{id} = \sqrt{\sigma_3^2 + 3\tau_3^2} \leq \dfrac{f_y}{\gamma_{M0}}$



Comportamento plastico

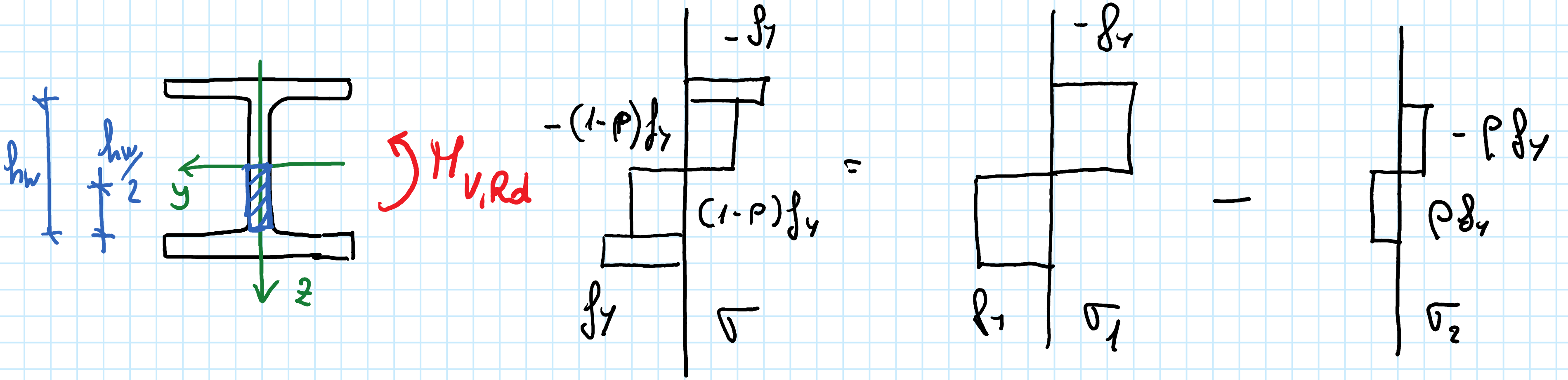
Classe 1 e 2

$M_{Ed} \leq M_{V,Rd}$

La plasticizzazione si avrà quando $\sigma_{id} = \sqrt{\sigma^2 + 3\tau^2} = f_y$, Nell'anima permane $\sigma < f_y$. Questa σ si assume pari a $(1-\rho) f_y$ con $0 < \rho < 1$

$$M_{V,Rd} = \int_A \sigma z \, dA$$

Il diagramma delle σ è quello indicato in figura.



$$\int \sigma z \, dA = \int_A \sigma_1 z \, dA - \int_A \sigma_2 z \, dA$$

$$M_{V,Rd} = \int_A \sigma z \, dA = W_{pl} f_y - W_{pl,w} \rho f_y = \left(W_{pl} - \frac{A_w^2 \rho}{4 t_w} \right) f_y$$

$$W_{pl,w} = 2 S^w_{1/2} = \cancel{2} \frac{h_w}{\cancel{2}} t_w \frac{h_w}{4} = \frac{t_w h_w^2}{4} \frac{t_w}{t_w} = \frac{t_w^2 h_w^2}{4 t_w} = \frac{A_w^2}{4 t_w}$$

Bisogna ancora considerare il coefficiente di sicurezza parziale γ_{M0} e calcolare ρ.

Momento resistente ridotto per effetto del taglio secondo le NTC 18

$$M_{V,Rd} = M_{Rd} = W_{pl} \frac{f_y}{\gamma_{M0}} \qquad \text{se} \quad V_{Ed} \leq 0,5\, V_{c,Rd}$$

$$M_{V,Rd} = \left(W_{pl} - \frac{A_w^2\, \rho}{4 t_w} \right) \frac{f_y}{\gamma_{M0}} \qquad \text{se} \quad V_{Ed} > 0,5\, V_{c,Rd}$$

$$\rho = \left(2 \frac{V_{Ed}}{V_{c,Rd}} - 1 \right)^2$$