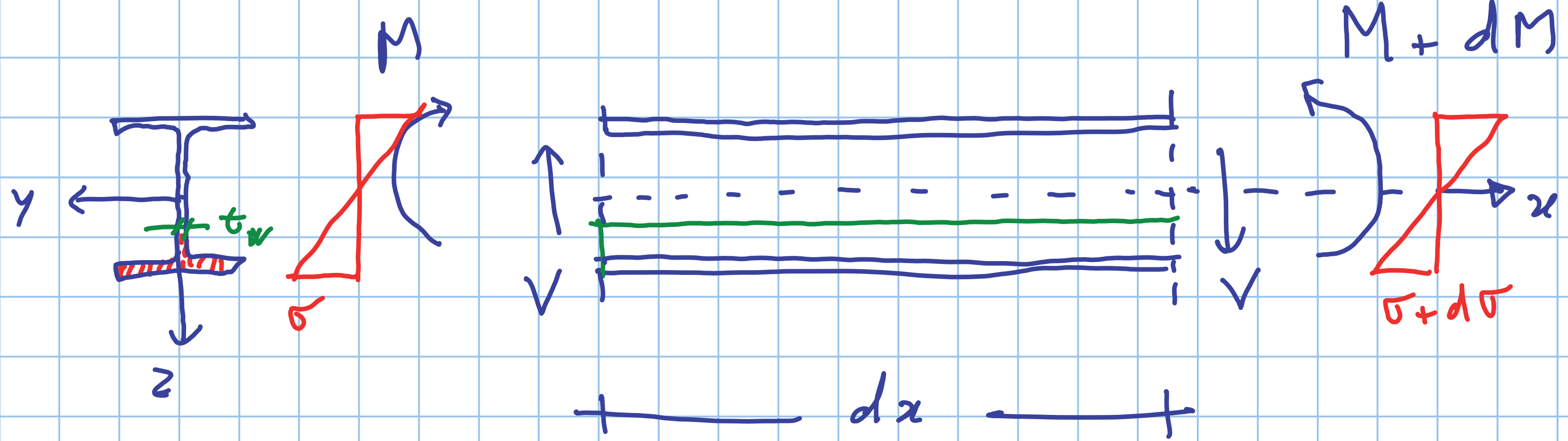
TAGLIO V

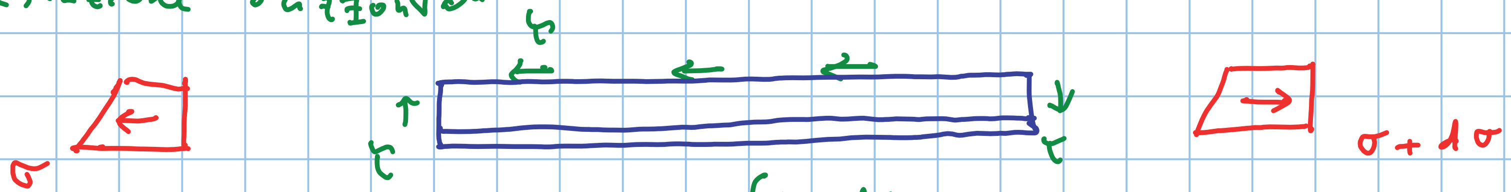
$$d\sigma = \frac{dM}{I_y} z \qquad \sigma = \frac{M_y}{I_y} z$$

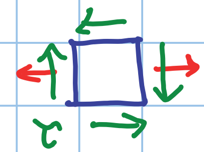


$$\frac{dM}{dx} = V$$

$$dM = V\,dx$$

Eq. traslazione orizzontale





$$\leftarrow \underbrace{\int \tau\, dA}_{\tau\ dx \cdot t_w}$$

$$\rightarrow \underbrace{\int d\sigma \cdot dA}_{\frac{dM}{I_y}\int z\, dA} = \frac{V\,dx}{I_y} S_y$$

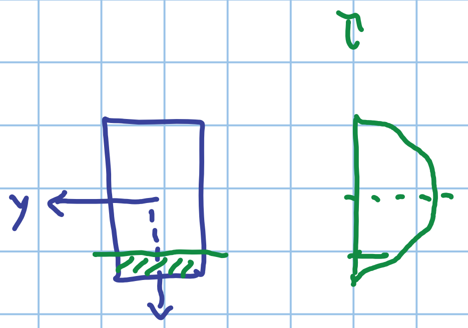
$$\tau\, \cancel{dx}\, t_w = \frac{V\, \cancel{dx}}{I_y} S_y$$

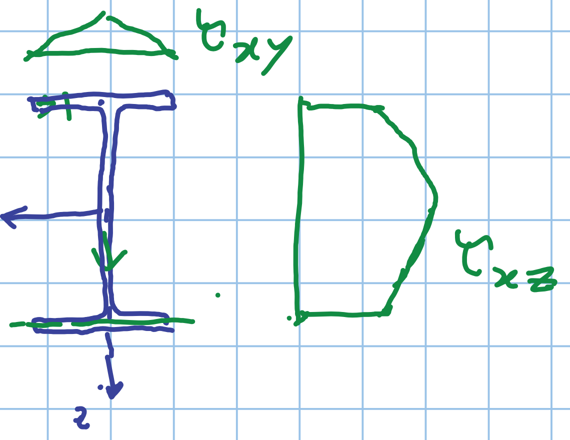
$$\tau = \frac{V S_y}{I_y t_w}$$

Jourawsky

ELASTICO LINEARE

$$\tau = \frac{V\,S}{I\,b}$$





$$V_z = \int \tau_{xz}\, dA \qquad \int \tau_{xy}\, dA = 0$$

$$\tau_{max} = \frac{V\,S_{1/2\,sez}}{I\,t_w}$$

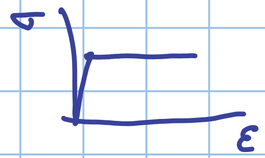
$$\sigma_{id} = \sqrt{\sigma^2 + 3\,\tau^2}$$

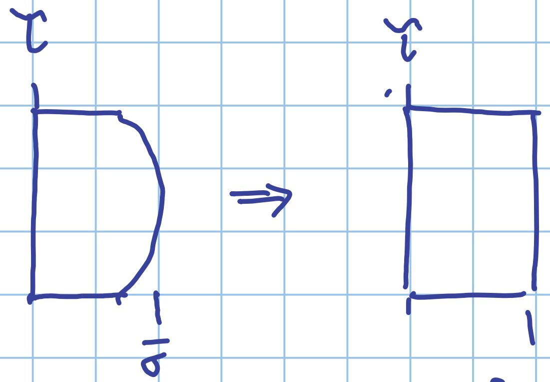
solo $\tau \rightarrow \sigma_{id} = \sqrt{3}\,\tau$

$$\sigma_{id} \leq \bar{\sigma} \Rightarrow \tau_{max} \leq \frac{\bar{\sigma}}{\sqrt{3}}$$

$$\tau_{max} = \frac{f_y/\sqrt{3}}{\gamma_{M0}}$$

NON LINEARE

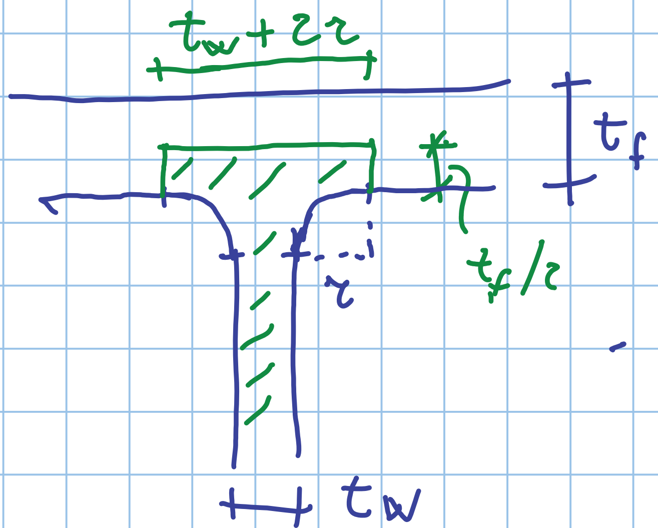




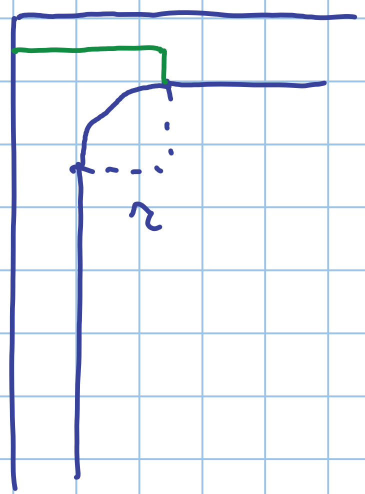
$$\frac{f_y/\sqrt{3}}{\gamma_{M0}} \qquad \frac{f_y/\sqrt{3}}{\gamma_{M0}}$$

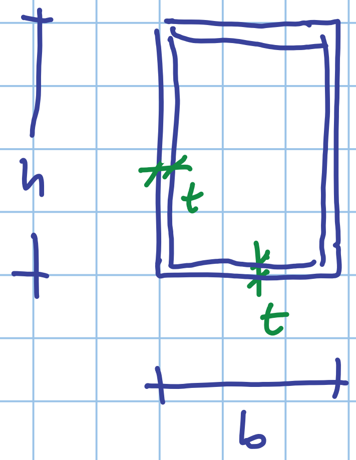
$$V = \int \tau_{xz}\, dA = \frac{f_y/\sqrt{3}}{\gamma_{M0}} \int dA$$

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



$$A_v = A - 2\,b\,t_f + (t_w + 2r)\frac{t_f}{\cancel{2}}\cancel{\cdot 2}$$





$$A_v \simeq 2ht$$

$$A_v = A \frac{h}{b+h}$$

IPE 200

S 275

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

$$= 2850 - 2 \times 100 \times 8.5 + (5.6 + 2 \times 12) \times 8.5 = 1402 \text{ mm}^2$$

$$= 14.02 \times 10^2$$

$$t_w b = 5.6 \times 200 = 11.2 \times 10^2 \text{ mm}^2$$

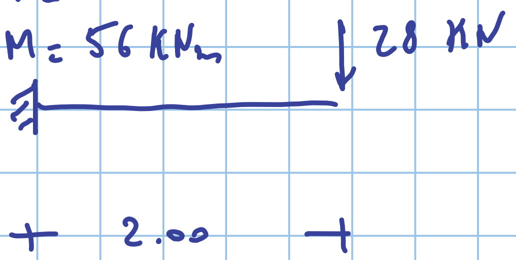
$$V_{Rd} = 14.0 \times 10^2 \times \frac{275/\sqrt{3}}{1.05} = 211.7 \text{ kN}$$

TAGLIO + MOMENTO FLETTENTE

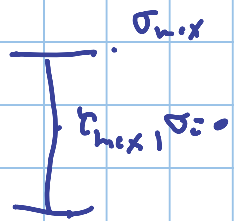
lineare

$V = 28\ kN$

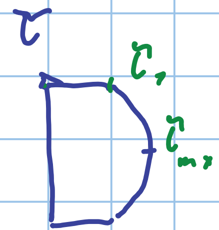
$M = 56\ kNm$



IPE 200

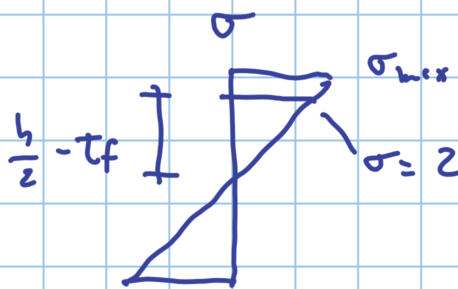


all'estremo



$$\tau_{max} = \frac{28\times10^3 \times 110.3\times10^3}{1943\times10^4 \times 5.6} = 28.4\ N/mm^2$$

$$\tau = \frac{V \cdot b \cdot t_f \cdot (h-t_f)/2}{I\ t_w} = \frac{28\times10^3\times100\times8.5\times95.75}{1943\times10^4\times5.6} = 20.9\ MPa$$



$$\sigma_{max}\,\frac{h/2 - t_f}{h/2}$$

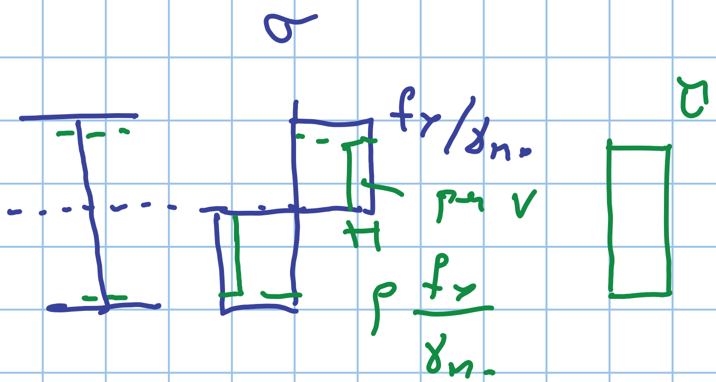
$$\sigma = 263.7 = \frac{M}{I}\,y$$

$$\sigma_{max} = \frac{M}{W_{el}} = \frac{56\times10^6}{194.3\times10^3} = 288.2\ MPa$$

$$288.2 \le \frac{f_y}{\gamma_{M0}}$$

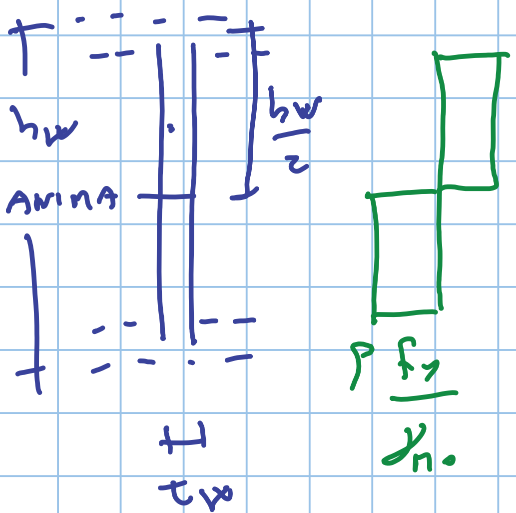
NON VERIFICA

$$\sqrt{263.7^2 + 3\times20.9^2} = 266.2\ MPa$$



non lineare

$$\boxed{\begin{aligned} &\rho = \left(\frac{2V_{Ed}}{V_{Rd}} - 1\right)^2 \quad \text{per } V_{Ed} > \frac{V_{Rd}}{2} \\ &\rho = 0 \quad \text{per } V_{Ed} \le \frac{V_{Rd}}{2} \end{aligned}}$$



$\rho \frac{f_y}{\gamma_{M0}}$ che servono per V

$$M_{\text{da sottrarre}} = \underbrace{2\, S_{y_{2m}}}_{\frac{h_w}{2} \times t_w \cdot \frac{h_w}{4} \times 2} \rho \frac{f_y}{\gamma_{M0}} = \frac{A_v^2}{4 t_w} \rho \frac{f_y}{\gamma_{M0}}$$

$$\frac{h_w^2 t_w}{4} = \frac{h_w^2 t_w^2}{4 t_w} = \frac{A_v^2}{4 t_w}$$

$$M_{Rd(V)} = \left(W_{pl} - \frac{A_v^2}{4 t_w} \rho\right) \frac{f_y}{\gamma_{M0}}$$

IPE 200

$W_{pl} = 220.6 \times 10^3 \ mm^3$

$A_v = 14.0 \times 10^2 \ mm^2$

$t_w = 5.6 \ mm$

$$\frac{A_v^2}{4 t_w} = \frac{1400^2}{4 \times 5.6} = 87.5 \times 10^3 \ mm^3$$

$M_{Rd} = (220.6 - \rho \, 87.5) \times 10^3 \times \frac{275}{1.05}$

$V_{Ed} = 28 \ KN \qquad V_{Rd} = 211.7 \ KN$

$V_{Ed} < \frac{211.7}{2} \Rightarrow \rho = 0$

105.85

x inverse $\quad V_{Ed} = 112 \ KN$

$V_{Ed} > \frac{V_{Rd}}{2} \qquad \rho = \left(\frac{2 \times 112}{211.7} - 1\right)^2 = 0.0034$

$V_{Ed} = 180 \ KN$

$$\rho = \left(\frac{2 \times 180}{211.7} - 1\right)^2 = 0.491$$