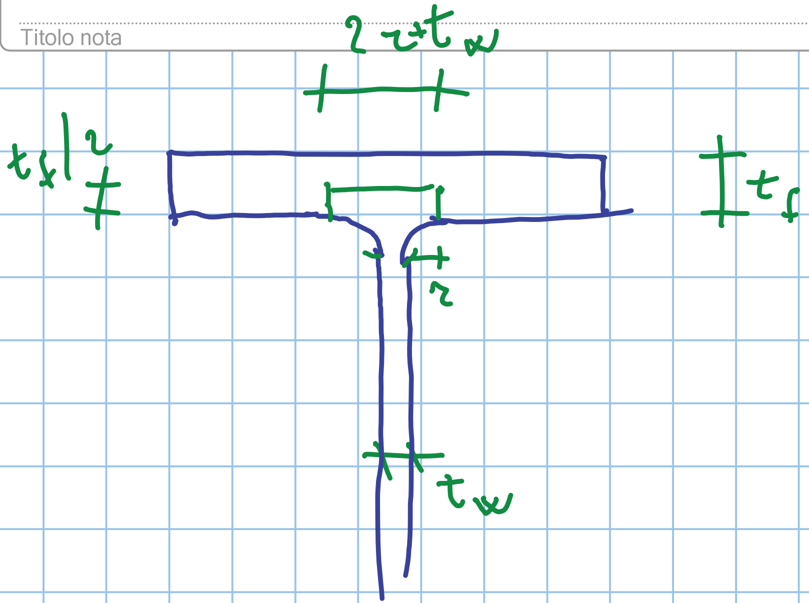
Titolo nota 12/12/2018



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

IPE 360

$b = 170$ mm

$h = 360$ mm

$t_f = 12.7$ mm

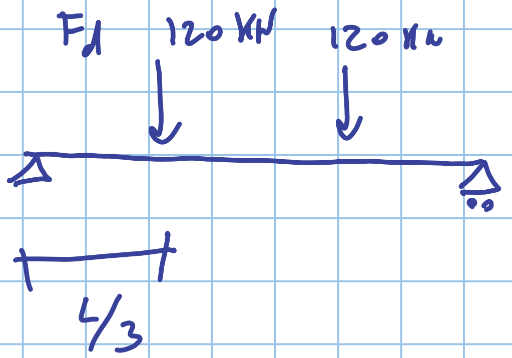
$t_w = 8$ mm

$r = 18$ mm

$A = 72.7 \times 10^2$ mm^2

$$A_v = 7270 - 2 \times 170 \times 12.7 + (2 \times 18 + 8) \times 12.7 = 3511 \text{ mm}^2$$

sagomari: $35{,}14 \times 10^2$ mm^2



$L = 6.50\ m$

$$M_{Ed} = \frac{FL}{3} = \frac{120 \times 6.50}{3} = 260\ kNm$$

S 275

$$IPE\ 360 \rightarrow W_{pl} = 1019 \times 10^3\ mm^3$$

ok

$$W_{pl} \geq \frac{260 \times 10^6 \times 1.05}{275} = 992.7 \times 10^3\ mm^3$$

$$V_{Ed} = 120\ kN$$

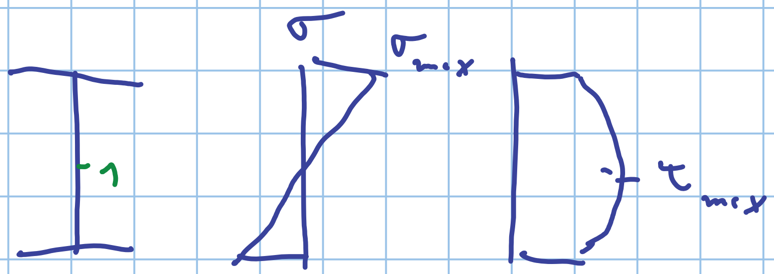
$$V_{Rd} = A_v \frac{f_y/\sqrt{3}}{\gamma_{M0}} = 35.14 \times 10^2 \times \frac{275/\sqrt{3}}{1.05} \times 10^{-3} = 531.4\ kN$$

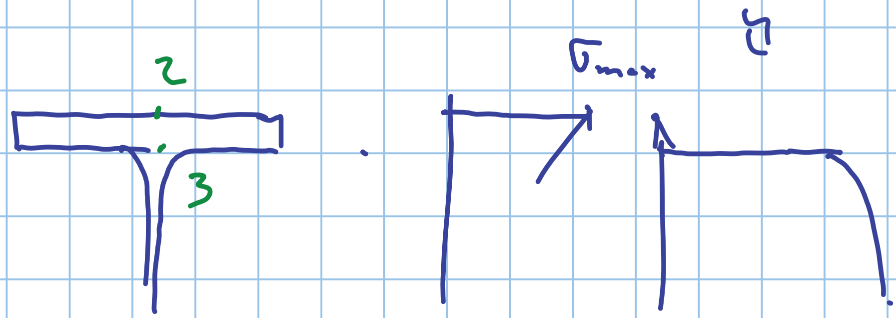
$$V_{Ed} << V_{Rd}$$

abbondantemente verificato

Presenza contemporanea di M e V

modello lineare



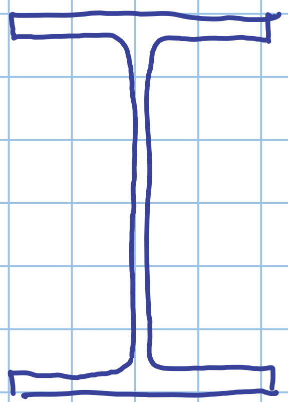


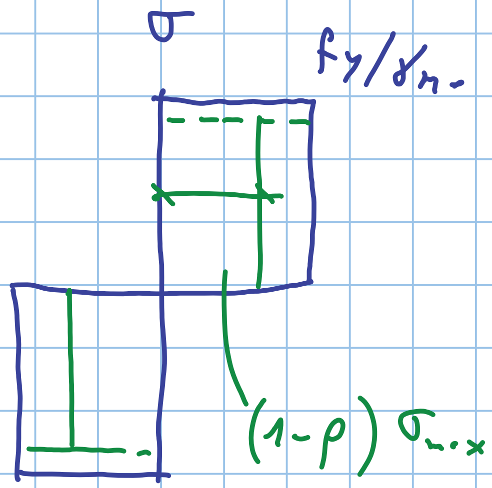
$$\sigma_{eq} = \sqrt{\sigma^2 + 3\tau^2}$$

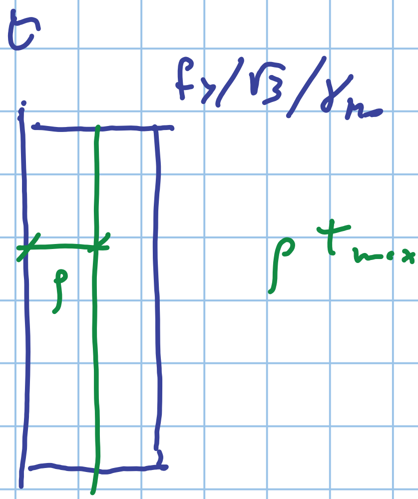
1 $\quad \sigma = 0 \quad \tau = \tau_{max}$

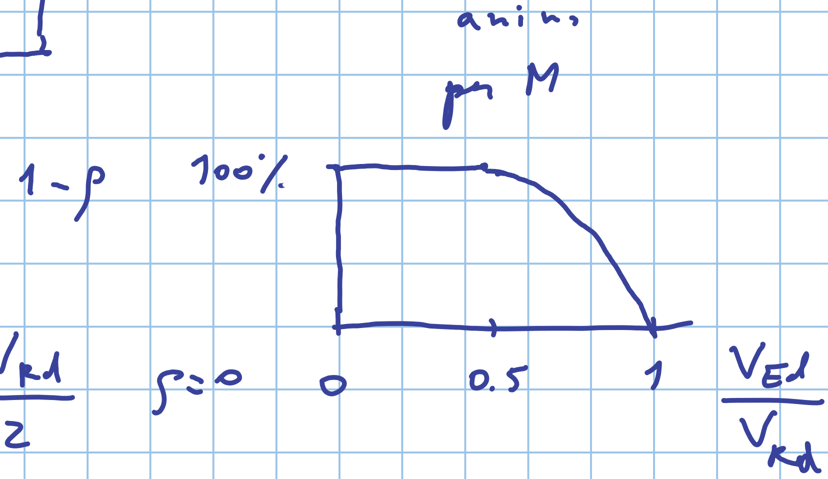
2 $\quad \sigma = \sigma_{max} \quad \tau = 0$

3 $\quad \sigma \quad \tau$





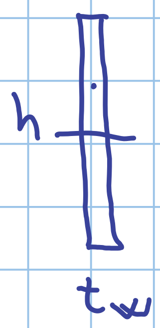




$$M_{Rd} = \left[W_{pl} - \rho\,?\right]\frac{f_y}{\gamma_{M0}} \qquad ? = \frac{A_v^2}{4\,t_w}$$

$$V_{Ed} \leq \frac{V_{Rd}}{2} \qquad \rho = 0$$

$$W_{pl} = 2\,S_{1/2}$$



$$S_{1/2} = t_w\,\frac{h}{2}\,\frac{h}{4}$$

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

$$W_{pl,v} = \frac{t_w h^2}{4} = \frac{t_w^2 h^2}{4\,t_w} = \frac{A_v^2}{4\,t_w}$$

IPE 360 $\qquad V_{Ed} = 360\ \text{kN} \qquad V_{Rd} = 531.4\ \text{kN}$

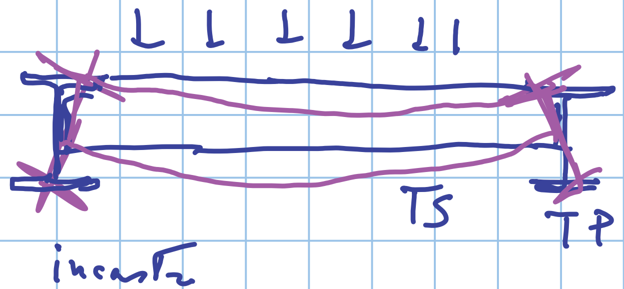
$$V_{Ed} > \frac{V_{Rd}}{2} \rightarrow \rho = \left(\frac{2\times 360}{531.4} - 1\right)^2 = 0.126$$

$$M_{Rd} = W_{pl}\frac{f_y}{\gamma_{M0}} = 1019\times10^3 \times \frac{275}{1.05} = 266.9\ \text{kNm} \qquad \text{for } \rho = 0$$

$$M_{Rd} = \left[W_{pl} - \frac{A_v^2}{4t_w}\rho\right]\frac{f_y}{\gamma_{M0}} = \left[1019\times10^3 - \underbrace{\frac{(35.14\times10^2)^2}{4\times 8}\times 0.126}_{48.6\times10^3}\right]\frac{275}{1.05} =$$

$$= 254.2\ \text{kNm}$$

TORSIONE



estremi incernierati

estremi incastrati

TS LIBERA di ruotare

TS ruota con TP

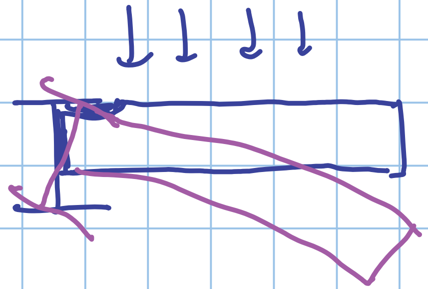
⇓

è indispensabile ?

TP ruota torsionalmente
per congruenza

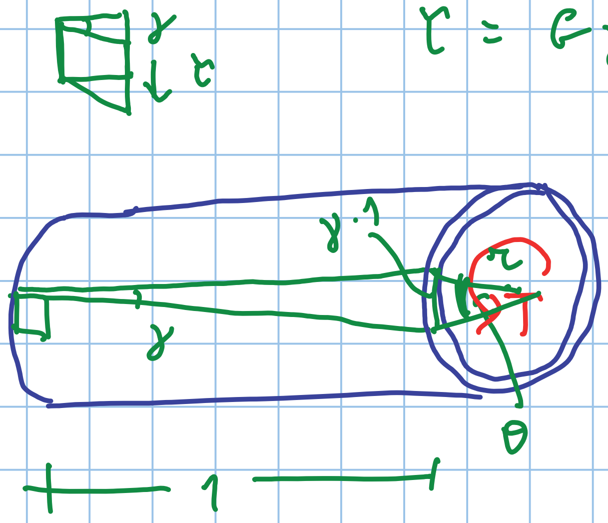
non indispensabile
per equilibrio

LA TORSIONE
SI TRASCURA



la torsione è indispensabile
per l'equilibrio

LA TORSIONE
SI CONSIDERA



$$\tau = G\gamma$$

$$\theta = \frac{\gamma}{r}$$

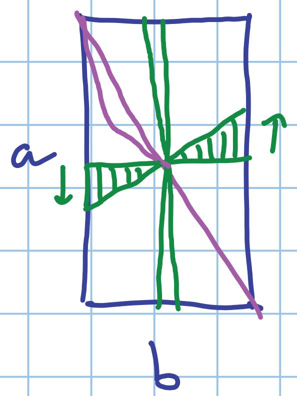
$$I_t = \int r^2 \, dA$$

$$\tau = G\theta r$$

$$T = \int \tau \, dA \, r = \int G \theta r^2 \, dA = G\theta I_t$$

$$\theta = \frac{T}{G I_t}$$

$$\tau = \frac{T}{I_t} r$$



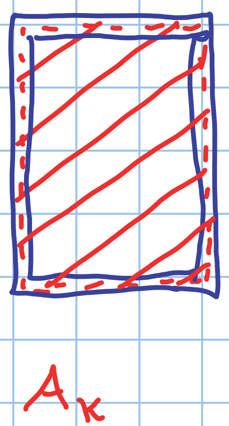
$$\tau_{max} = \psi \frac{T}{a b^2} \qquad b \ll a \qquad \psi = 3$$

$b \leq a$

nei profili in acciaio (aperti)

il b è lo spessore t, molto piccolo

quindi τ molto grandi



$$\tau_{max} = \frac{T}{2\, t_{min} A_K}$$

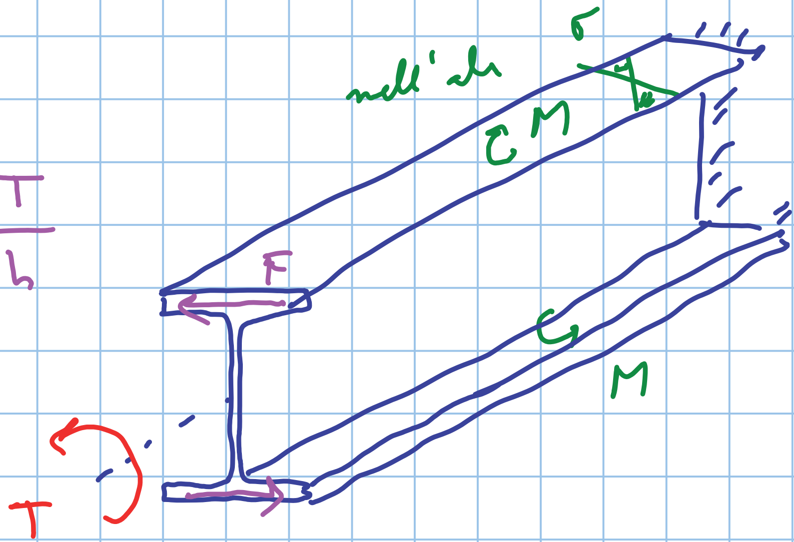
BREDT

i profili chiusi portano bene la torsione

verifica $\tau_{max} \leq \dfrac{f_y/\sqrt{3}}{\gamma_m}$

profili aperti soggetti a T   non vale Teoria di De Saint Venant

TEORIA DI VLASOV   per t molto piccolo



$F = \frac{T}{h}$

bimomento B

(coppia di momenti per braccio)

$$\sigma = \frac{B}{I_\omega}\omega$$