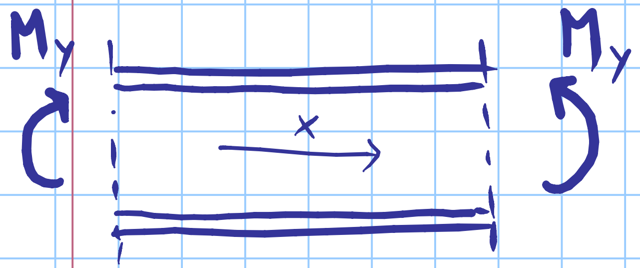
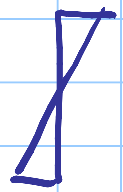
FLESSIONE SEMPLICE RETTA

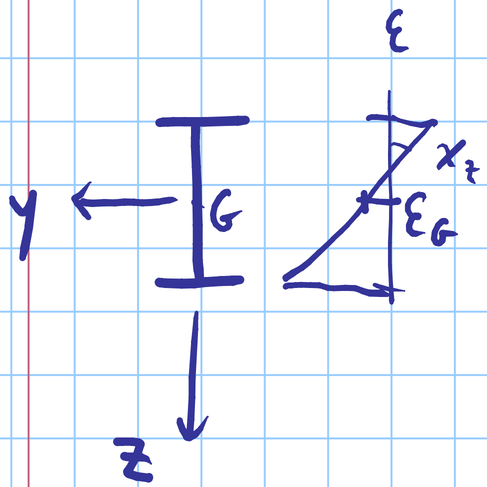
Titolo nota 12/11/2013





comportamento in campo elastico

$$\sigma = E\,\varepsilon$$



mantenimento sezione piana

$$\varepsilon = \varepsilon_G + \chi_z\, z$$

$$\chi_z = \frac{1}{r} = \frac{d\varepsilon}{dz}$$

$$N = \int \sigma \, dA = \int E(\varepsilon_G + \chi_z z) \, dA =$$

$$= E \varepsilon_G \underbrace{\int dA}_{A} + E \chi_z \underbrace{\int z \, dA}_{S_y = 0} = E \varepsilon_G A$$

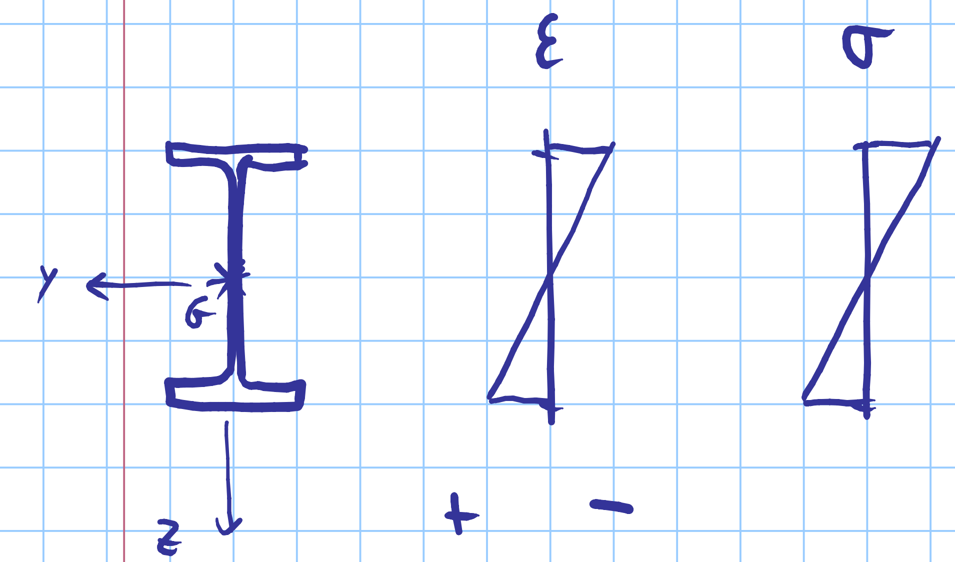
$$\varepsilon_G = \frac{N}{EA}$$

flessione semplice $\quad N = 0 \Rightarrow \varepsilon_G = 0$

$$M_y = \int \sigma z \, dA = \int E(\varepsilon_c + \chi_z z) z \, dA =$$

$$= E \varepsilon_c \underbrace{\int z \, dA}_{S_y = 0} + E \chi_z \underbrace{\int z^2 \, dA}_{I_y} = E \chi_z I_y$$

$$\chi_z = \frac{M_y}{E I_y} \qquad \sigma = \underbrace{\varepsilon_c}_{\downarrow\, 0} + \underbrace{\chi_z}_{\downarrow\, \frac{M}{EI}} z = \frac{M_y}{E I_y} z$$

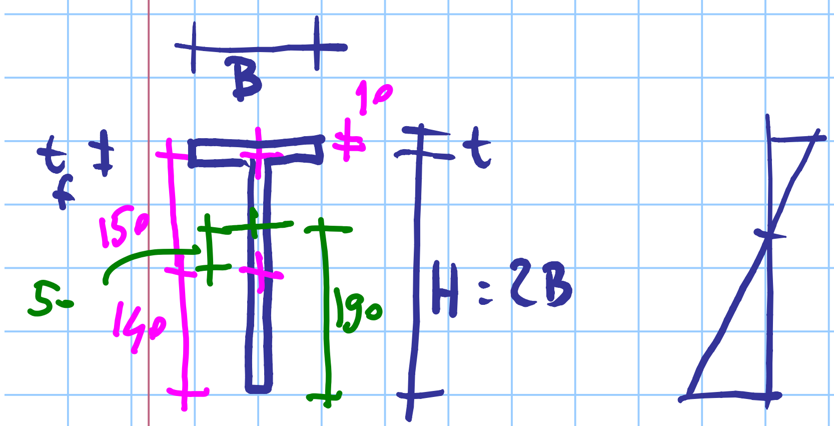


$$\sigma = \frac{M}{I} z \leq \bar{\sigma}$$

$$|\sigma_{max}| = \frac{M}{I} |z_{max}|$$

$$\frac{I}{|z_{max}|} = W$$ modulo di resistenza

$$\sigma_{max} = \frac{M}{W}$$



$t_w = t_f$

H = 280 mm

B = 140 mm

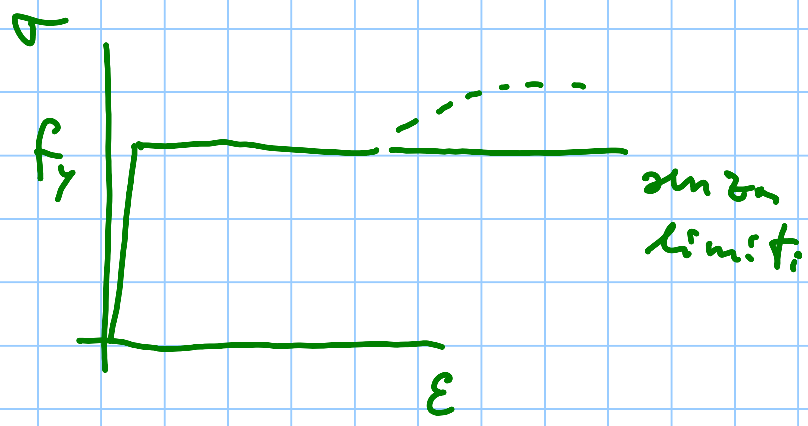
t = 20 mm

ANDANDO OLTRE IL LIMITE ELASTICO

comportamento in campo elastico

$$\sigma = E\,\varepsilon$$

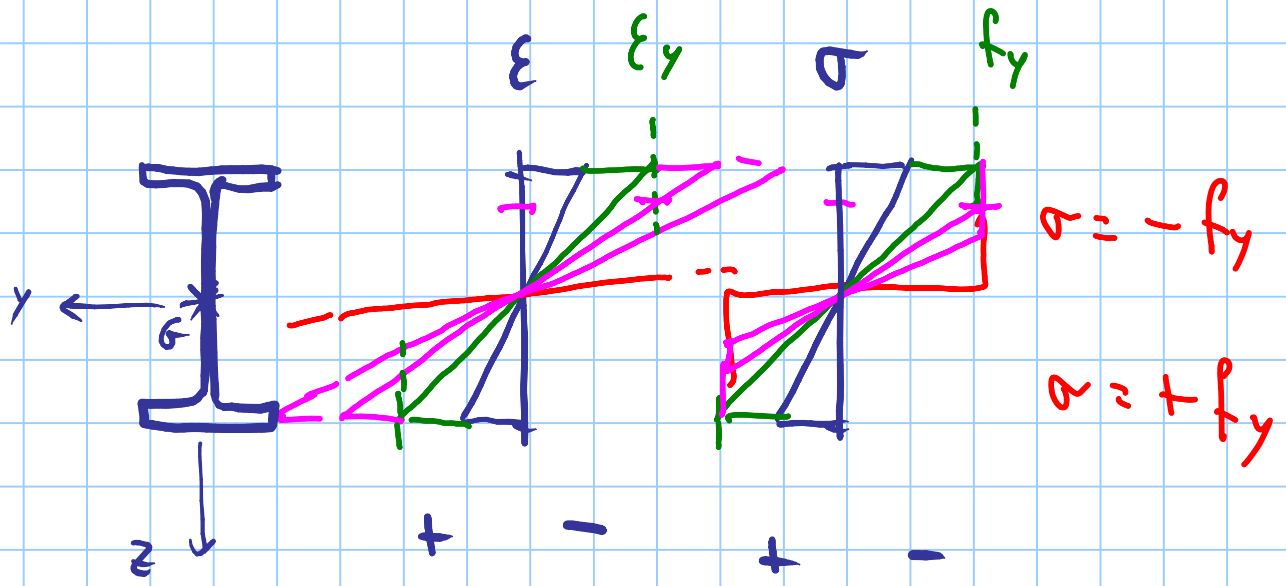
NO



mantenimento sezione piana

$$\varepsilon = \varepsilon_G + \chi_z\, z$$

SI



$$\sigma = \frac{M}{W} = f_y$$

$$M = W f_y$$

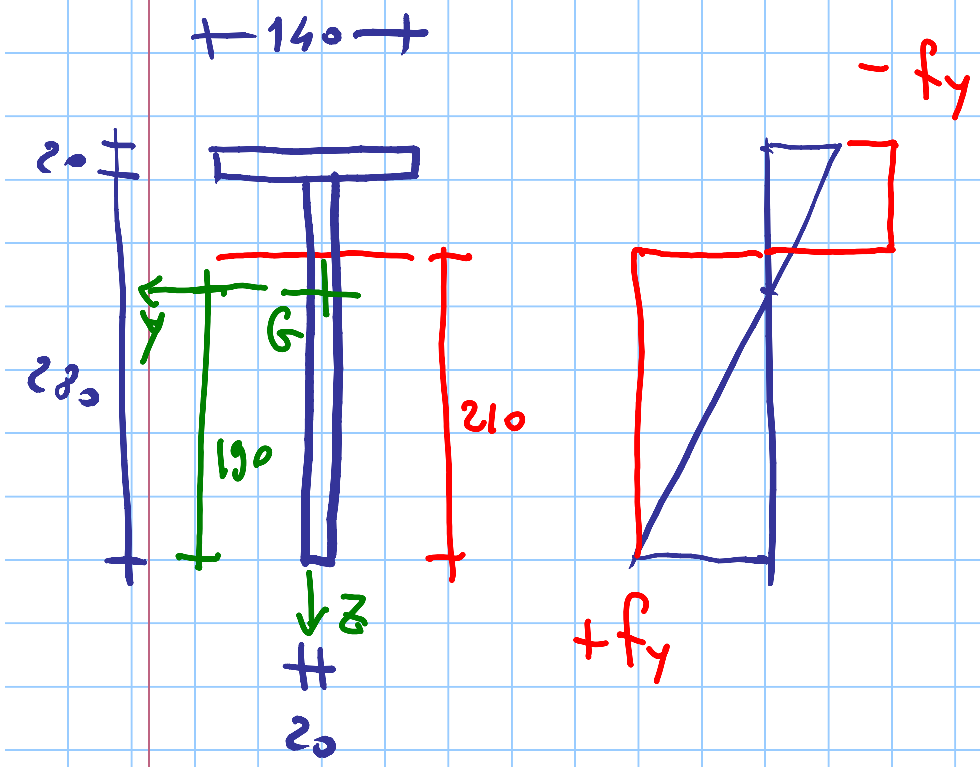
$$N = \int \sigma \, dA = 0$$

$$N = \int_{tens} \sigma \, dA + \int_{comp} \sigma \, dA = f_y \int_{tens} dA - f_y \int_{comp.} dA =$$

$+f_y$ $\qquad$ $-f_y$

$$= f_y A_{tens.} - f_y A_{comp}$$

$$N = 0 \Rightarrow A_{tens} = A_{comp}$$



140
20
280
y
G
190
210
z
20
- fy
+ fy

$$M_y = \int \sigma z \, dA = \int_{tens} \sigma z \, dA + \int_{comp} \sigma z \, dA =$$

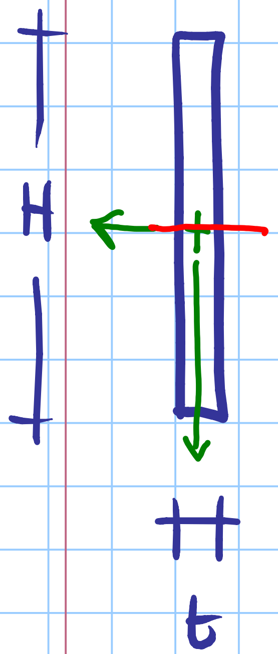
$$= f_y \underbrace{\int_{tens} z \, dA}_{S_{tens,y}} - f_y \underbrace{\int_{comp} z \, dA}_{S_{comp,y}} = 2 f_y S_{tens,y}$$

$$S_y = S_{tens,y} + S_{compr,y} = 0 \Rightarrow S_{tens,y} = -S_{comp,y}$$

$$M_{pl,y} = \underbrace{2\, S_{max\,x\,?,y}}_{W_{pl}} \cdot f_y$$

in campo elastico

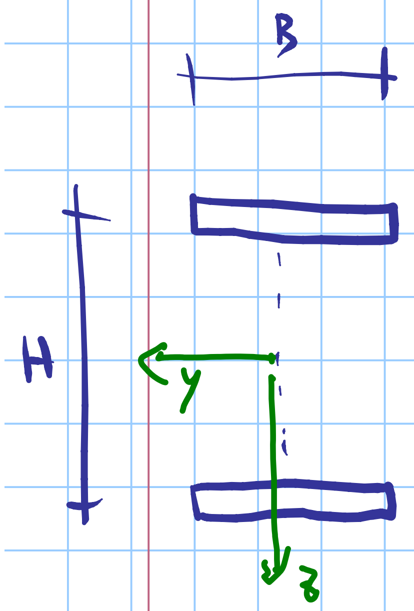
$$M = W_{el} \cdot \sigma$$



$$W_{el} = \frac{I}{z_{max}} = \frac{t H^3/12}{H/2} = \frac{t H^2}{6}$$

$$W_{pl} = 2\, S_{y/2} = 2\, t\, H/2 \cdot H/4 = \frac{t H^2}{4}$$

$$\frac{W_{pl}}{W_{el}} = \frac{t H^2/4}{t H^2/6} = 1.5$$ fattore di forma



$\updownarrow t$ piccolo

senz'anima

$$W_{el} = \frac{Bt \cdot (H/2)^2 \cdot 2}{H/2} = B\,t\,H$$

Trascurato

$Bt^3/12$

$$W_{pl} = 2 \cdot Bt \cdot \frac{H}{2} = B\,t\,H$$

$$\frac{W_{pl}}{W_{el}} = 1$$

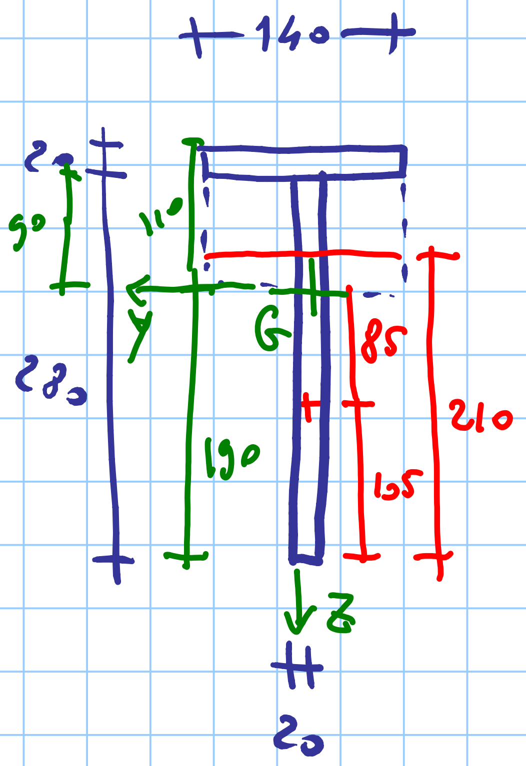
per sezioni HE , IPE $\qquad \dfrac{W_{pl}}{W_{el}} \simeq 1.15$

es. IPE 180 $\qquad$ HEB 180

$W_{el} = 146.3 \times 10^3 \ mm^3 \qquad 425.7 \times 10^3 \ mm^3$

$W_{pl} = 166.4 \times 10^3 \ mm^3 \qquad 481.4 \times 10^3 \ mm^4$

$\dfrac{W_{pl}}{W_{el}} = 1.137 \qquad 1.131$



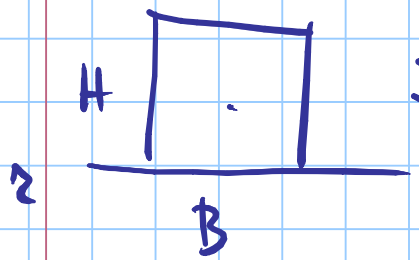
$$I = \frac{20 \times 190^3}{3} + \frac{140 \times 110^3}{3} - \frac{120 \times 90^3}{3} =$$

$$= 0.7868 \times 10^8 \ mm^4$$

$$W_{el} = \frac{I}{z_{max}} = \frac{0.7868 \times 10^8}{190} = 0.4141 \times 10^6 \ mm^3$$

$$S_{1/2} = 210 \times 20 \times 85 = 0.357 \times 10^6 \ mm^3$$

$$W_{pl} = 2 \times 0.357 \times 10^6 = 0.714 \times 10^6 \ mm^3$$



$$I_z = \frac{B H^3}{3}$$

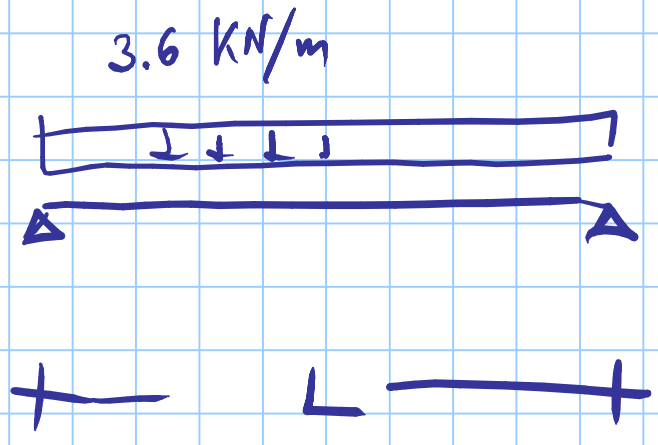
$$M_{pl,Rd} = W_{pl} \frac{f_y}{\gamma_{M0}}$$

VERIFICA

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

PROGETTO

$$W_{pl} \geq \frac{M_{Ed}}{f_y/\gamma_{M0}}$$



$L = 6.00\ m = 6000\ mm$

$g_k = 1.1\ KN/m$

$q_k = 2.5\ KN/m$

$g_d = 1.1 \times 1.3 = 1.43\ KN/m$

$q_d = 2.5 \times 1.5 = 3.75\ KN/m$

$5.18\ KN/m$

$$M_{Ed} = \frac{ql^2}{8} = \frac{5.18 \times 6.00^2}{8} = 23.31\ KNm$$

S275

$$W_{pl} \geq \frac{23.31 \times 10^6}{275/1.05} = 89.0 \times 10^3 \ mm^3$$

IPE 160 $\qquad W_{pl} = 123.9 \times 10^3 \ mm^3 \qquad I = 869.3 \times 10^4 \ mm^4$

dalla verifica a deformazione $\qquad I \geq 964.3 \times 10^4 \ mm^4$

non basta IPE 160, serve IPE 180