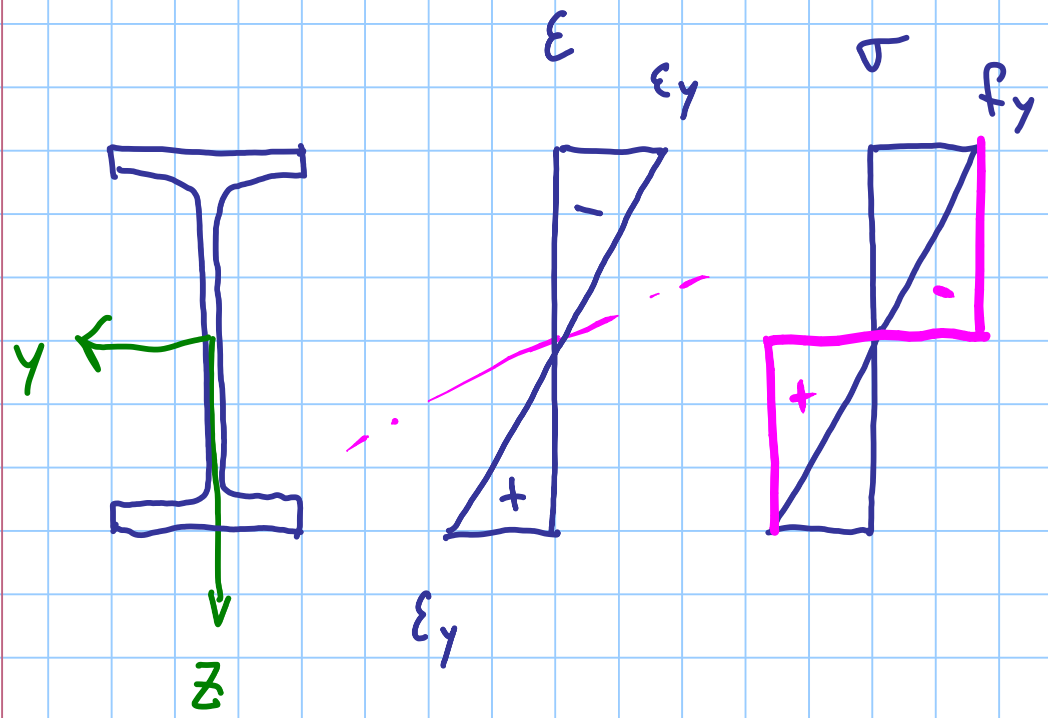
FLESSIONE

Titolo nota 11/11/2014

elasticità lineare



$$\sigma = \frac{N}{A} + \frac{M_y}{I_y} z - \frac{M_z}{I_z} y$$

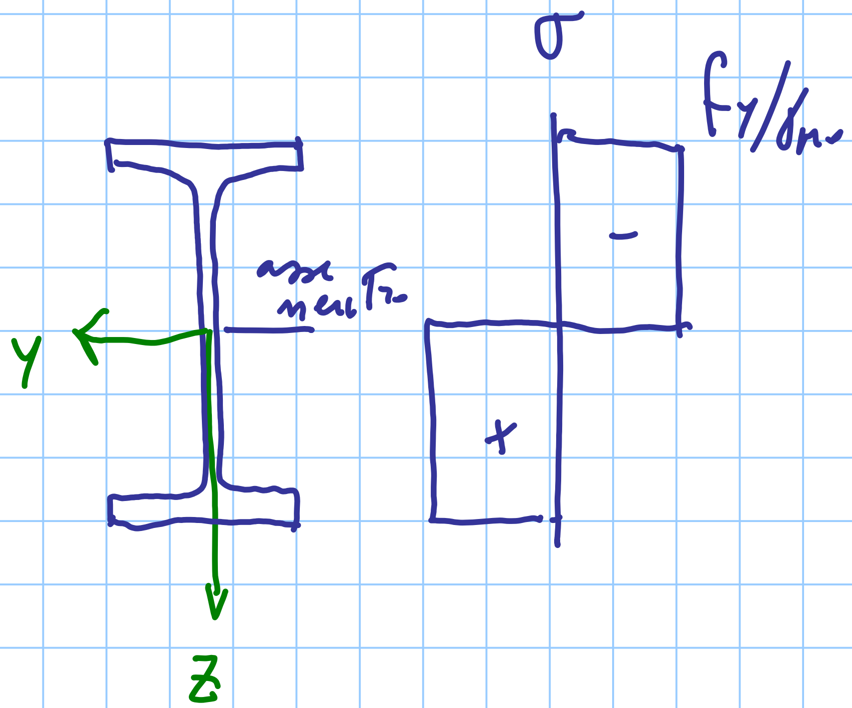
dall'equilibrio

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

$$M_y = \int \sigma z \, dA$$

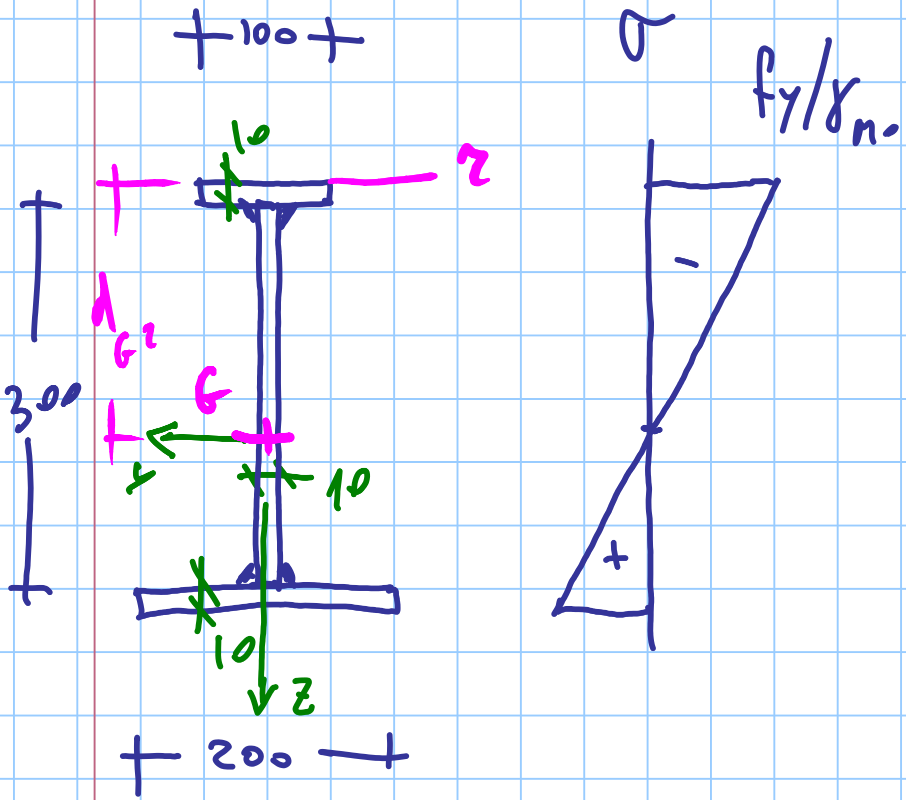
classe 3 $\sigma = \frac{M_y}{I_y} z$ $\sigma_{max} = \frac{M_y}{W_{y,el}}$ $\Rightarrow M_{Rd} = W_{el,y} \frac{f_y}{\gamma_{M0}}$

allo SLU non vale Navier, ecc.



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

$$M_y = \int \sigma z \, dA$$



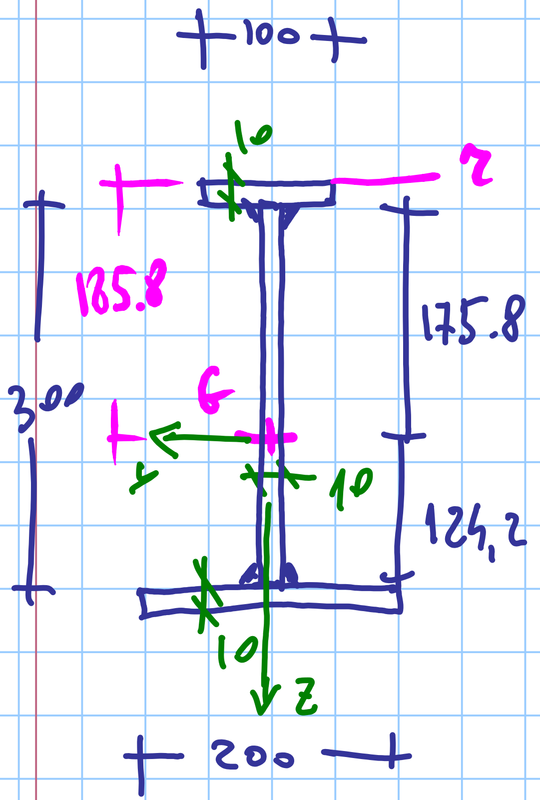
$$A = 60 \times 10^2 \ mm^2$$

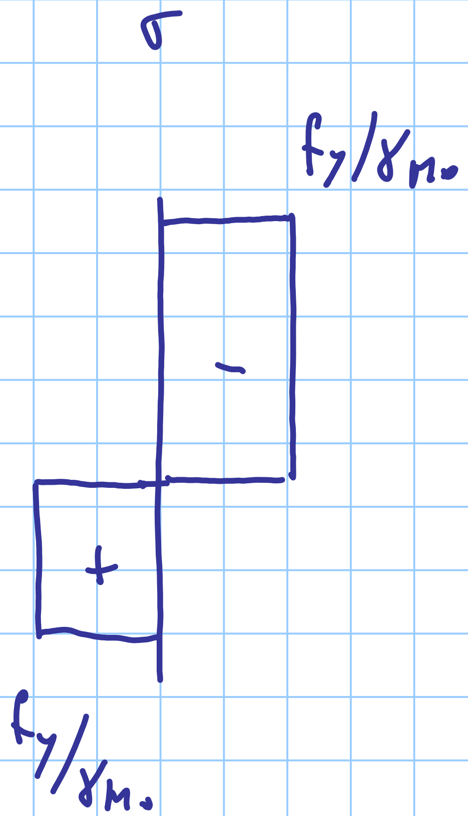
$$S_z = 5 \times 10^3 + 480 \times 10^3 + 630 \times 10^3 = 1115 \times 10^3 \ mm^3$$

$$d_{Gz} = \frac{S_z}{A} = \frac{1115 \times 10^3}{60 \times 10^2} = 185.8 \ mm$$

class 3

$$W_{el,y} = \frac{I_y}{d_{Gz}}$$





con questo diagramma ho flessione semplice ?

è N = 0 ?

per rispondere calcolo N

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

$$N = \int_{A_{t.i}} \sigma \, dA = \int_{A_+} \sigma \, dA + \int_{A_-} \sigma \, dA = \frac{f_y}{\gamma_{M0}} A_+ - \frac{f_y}{\gamma_{M0}} A_-$$

ala inf [200 x 10]

$$A_+ = 20 \times 10^2 + 12{,}42 \times 10^2 = 32{,}42 \times 10^2 \ mm^2$$

$$A_- = 10 \times 10^2 + 17{,}58 \times 10^2 = 27{,}58 \times 10^2 \ mm^2$$

ala sup [100 x 10]

$$N = \frac{f_y}{\gamma_{M0}} \left[A_+ - A_- \right] = \frac{f_y}{\gamma_{M0}} \left[32{,}42 \times 10^2 - 27{,}58 \times 10^2 \right]$$

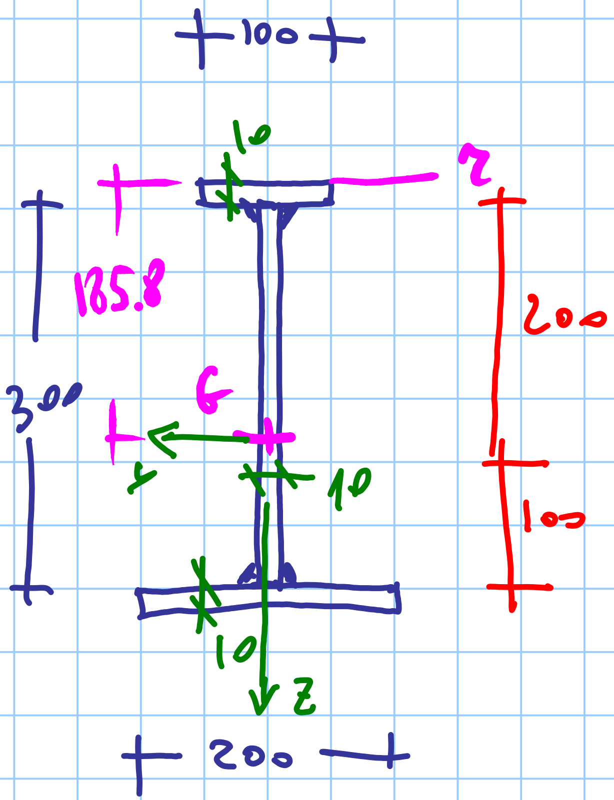
per avere $N = 0$

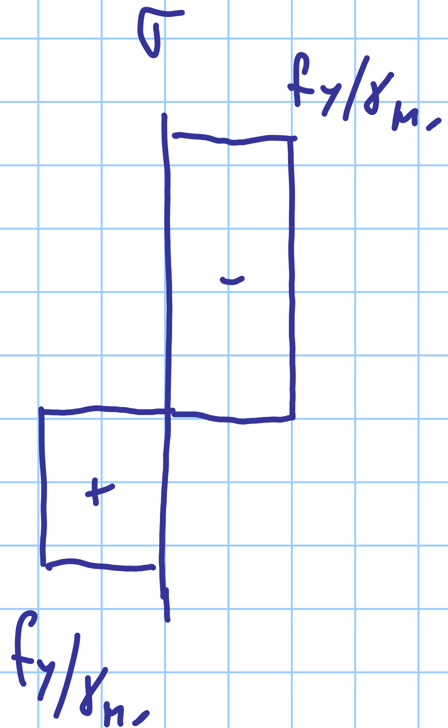
deve essere $A_+ = A_-$ area tesa = area compressa

Nota: vale perchè abbiamo un unico materiale

con f_y assegnato

come calcoliamo M_{Rd} ?





$$M_{Rd} = \int \sigma z \, dA$$

$$M_{Rd} = \int_{A_+} \sigma z \, dA + \int_{A_-} \sigma z \, dA =$$

$$= \frac{f_y}{\gamma_{M0}} \underbrace{\int_{A_+} z \, dA}_{S_{A+}} - \frac{f_y}{\gamma_{M0}} \underbrace{\int_{A_-} z \, dA}_{S_{A-}}$$

$$S_{A+} + S_{A-} = S_A = 0$$

momento statico
di una sezione risp. y

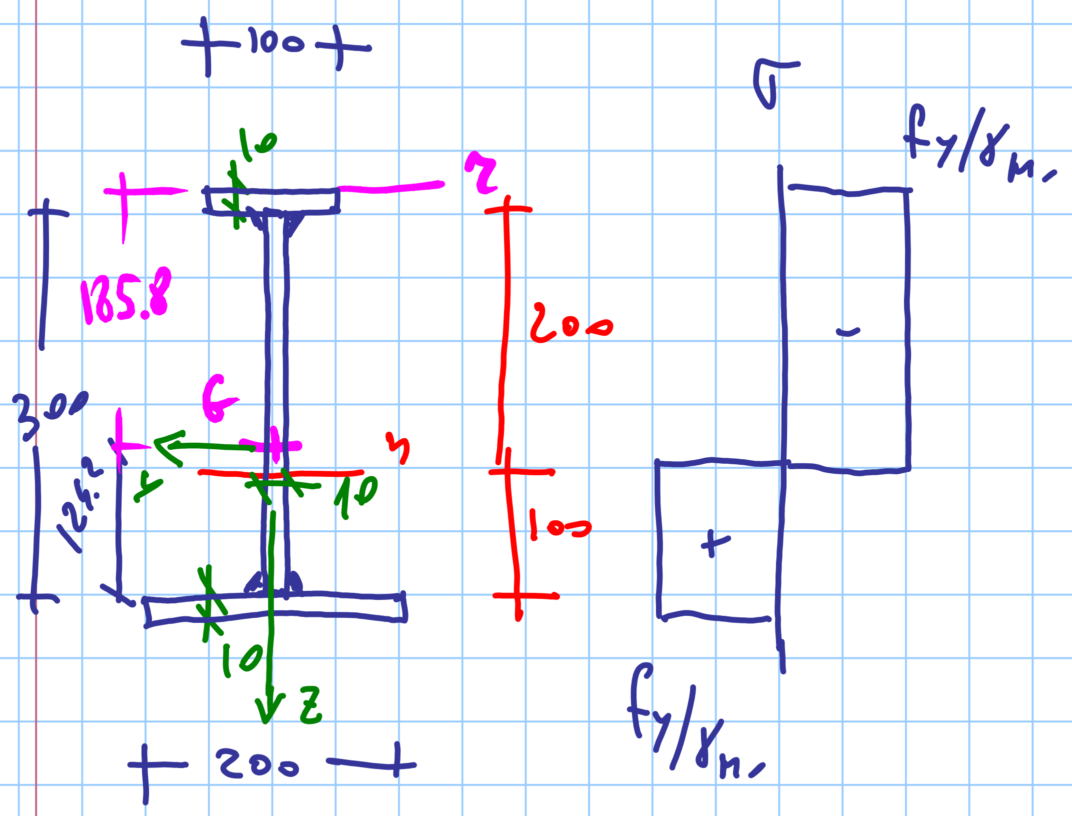
$$S_{A-} = -S_{A+}$$

$$M_{Rd} = \frac{f_y}{\gamma_{M0}} S_{A+} - \frac{f_y}{\gamma_{M0}} \left(-S_{A+}\right) = 2 S_{A+} \frac{f_y}{\gamma_{M0}}$$

$$M_{Rd} = \underbrace{2 S_{1/2}}_{W_{pl,y}} \frac{f_y}{\gamma_{M0}}$$

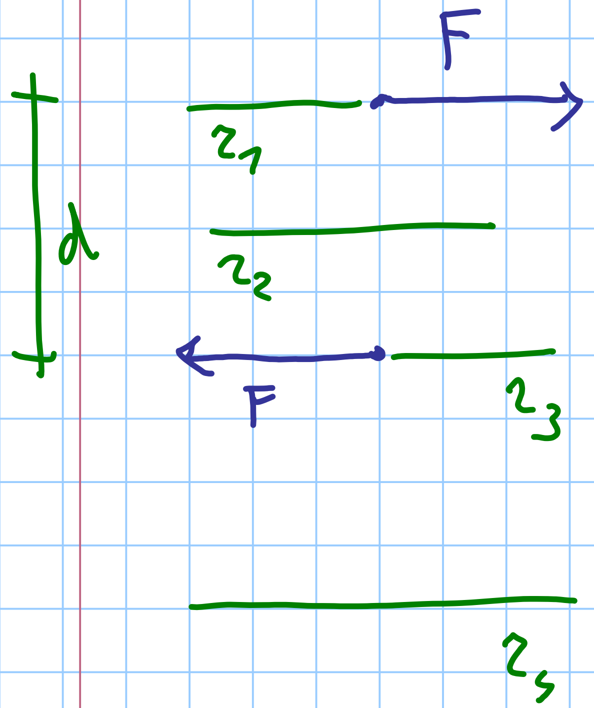
$$W_{pl,y} = 2 S_{1/2}$$

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



$$S_{A_+} = 2000 \times 129.2 + 1000 \times 74.2 = 332{,}6 \times 10^3 \ mm^3$$

$$W_{pl,y} = 2 \times 332.6 \times 10^3 = 665.2 \times 10^3 \ mm^3$$



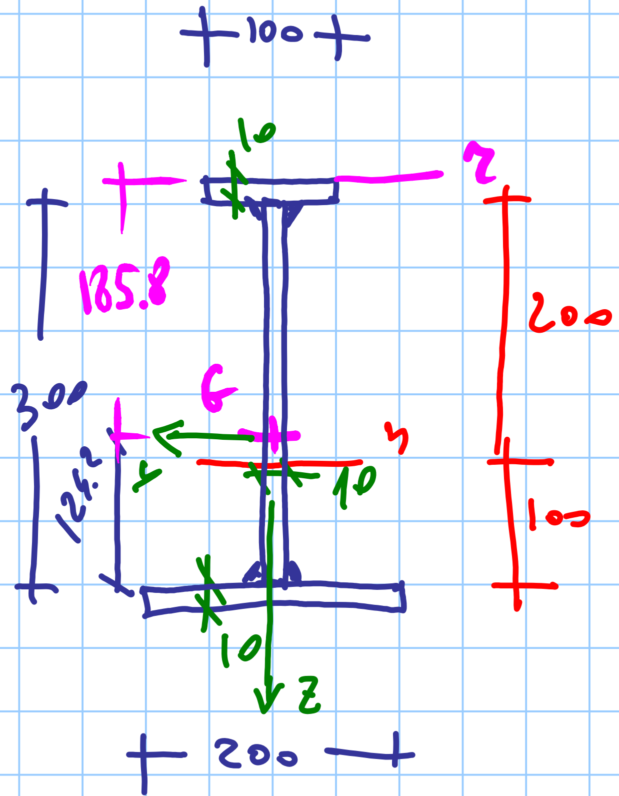
se ho una coppia

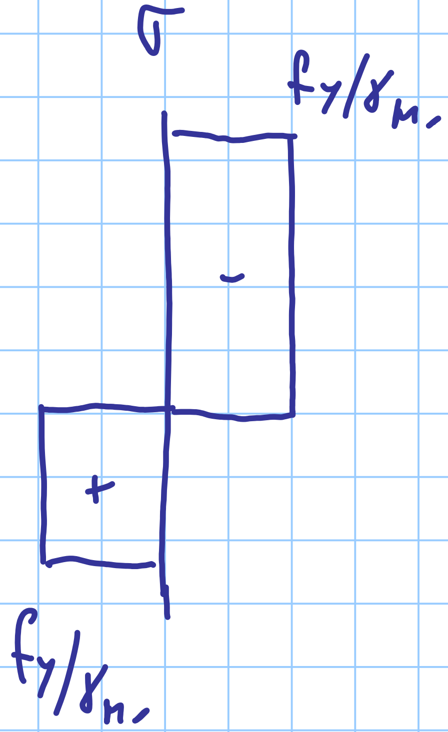
$(\vec{R} = 0)$

posso calcolare il momento

rispetto a qualunque asse

trovo sempre lo stesso

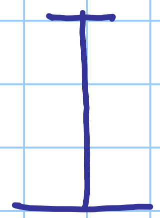




$N = 0$

potrei anche calcolare M rispetto all'asse neutro

$$M_{Rd} = \int \sigma \, dA = \frac{f_y}{\gamma_{M0}} \left[S_{A+,n} - S_{A-,n} \right]$$



per la sezione di prima

$$W_{pl,y} = 665.2 \times 10^3 \ mm^3$$

$$S275 \rightarrow f_y = 275 \ MPa$$

$$M_{Rd} = W_{pl,y} \frac{f_y}{\gamma_{M0}} = 665.2 \times 10^3 \ \frac{275}{1{,}05} \times 10^{-6} = 174.2 \ kNm$$

PROGETTO

$L = 6.00\ m$

$g_k = 0.5\ KN/m$

$q_k = 1.6\ KN/m$

per SLE

$$I \geq 562.5 \times 10^4\ mm^4 \rightarrow \text{IPE 160 o HE 120 A}$$

per SLU

$$g_d = g_k\, \gamma_g = 0.5 \times 1.3 = 0.65\ KN/m$$

$$q_d = q_k\, \gamma_q = 1.6 \times 1.5 = 2.4\ kN/m$$

$$3{,}05\ kN/m$$

S275

$$M_{Ed} = \frac{q l^2}{8} = \frac{3.05 \times 6.00^2}{8} = 13.73 \text{ kNm}$$

$$M_{Rd} = W_{pl,y} \frac{f_y}{\gamma_{M0}} \qquad M_{Ed} \leq M_{Rd}$$

$$M_{Ed} \leq W_{pl,y} \frac{f_y}{\gamma_{M0}} \rightarrow W_{pl,y} \geq M_{Ed} \frac{\gamma_{M0}}{f_y}$$

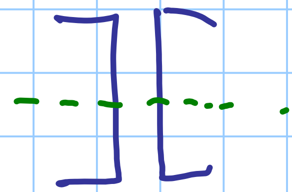
$$W_{pl,y} \geq 13.73 \times 10^6 \frac{1.05}{275} = 52.42 \times 10^3 \text{ mm}^3$$

IPE 120 $W_{pl,y} = 60,73 \times 10^3 \text{ mm}^4$ OK

ma per SLE occorre $I \geq 562.5 \times 10^4 \text{ mm}^4$

occorre un IPE 160

peso (m.) 15.8 Kg

si vogliono usare  due UPE

$W_{pl,y}$ per 1 profilo $\quad W_{pl,y} \geq \dfrac{52.42 \times 10^3}{2} = 26.21 \times 10^3 \ mm^3$

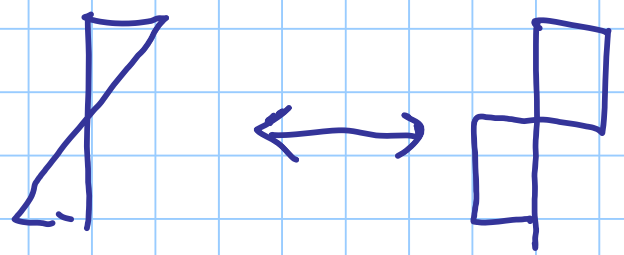
$$I_y \geq \frac{562.5 \times 10^4}{2} = 281.3 \times 10^4 \ mm^4$$

uso 2 UPE 120 $\quad W_{pl,y} = 70.33 \times 10^3 \times 2$

$$I_y = 363.5 \times 10^4 \times 2$$

peso massa $12.1 \times 2 = 24.2$ kg

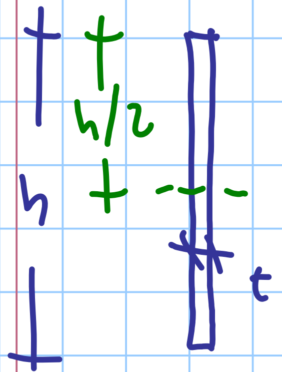
CONFRONTO $W_{el} \longleftrightarrow W_{pl}$



$\dfrac{W_{pl}}{W_{el}}$ fattore di forma

IPE 160 $\dfrac{123.9}{108.7} = 1.14$

HE 120 A $\quad \dfrac{119.5}{106.3} = 1.124$

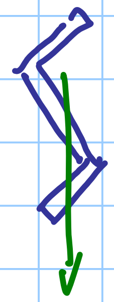


$$W_{el,y} = \frac{t h^3/12}{h/2} = \frac{t h^2}{6}$$

$$W_{pl,y} = 2\, S_{1/2} = 2 \times \frac{t h^2}{8} = \frac{t h^2}{4}$$

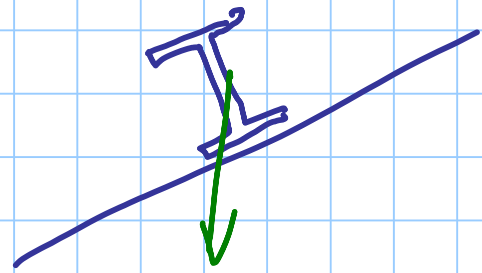
$$\frac{W_{pl,y}}{W_{el,y}} = 1.5$$

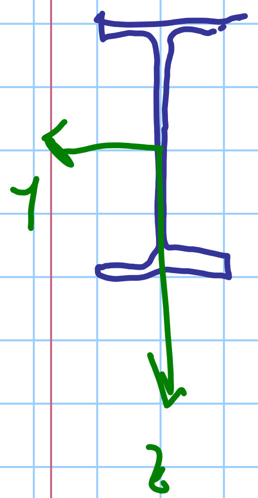
$$\frac{W_{pl,z}}{W_{el,z}}$$

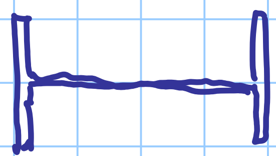


M_y

M_z

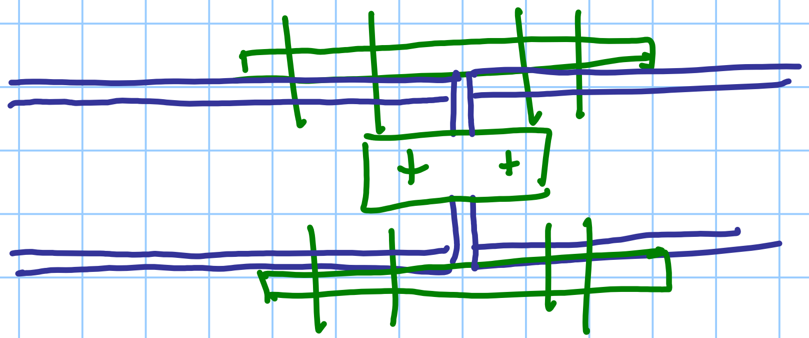


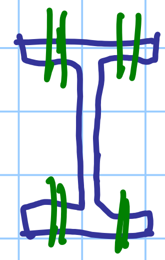




IPE 160 $\frac{26.10}{16.66} = 1.566$

HE 120 A $\frac{58.85}{38.48} = 1.529$





fori nell'ala

Asta tesa

resistenza a trazione

MIN

resist. asta non forata $A \dfrac{f_y}{\gamma_{M0}}$

resist. ultima in corr. foro $0.9 A_{net} \dfrac{f_{tk}}{\gamma_{M2}}$

se $$0.9\, A_{net} \frac{f_u}{\gamma_{M2}} \geq A \frac{f_y}{\gamma_{M0}}$$

non mi preoccupo della rottura in corrispondenza dei fori

$$\frac{A_{net}}{A} \geq \frac{f_y/\gamma_{M0}}{0.9\, f_u/\gamma_{M2}}$$

se questo vale per l'ala tesa stessa considerazione