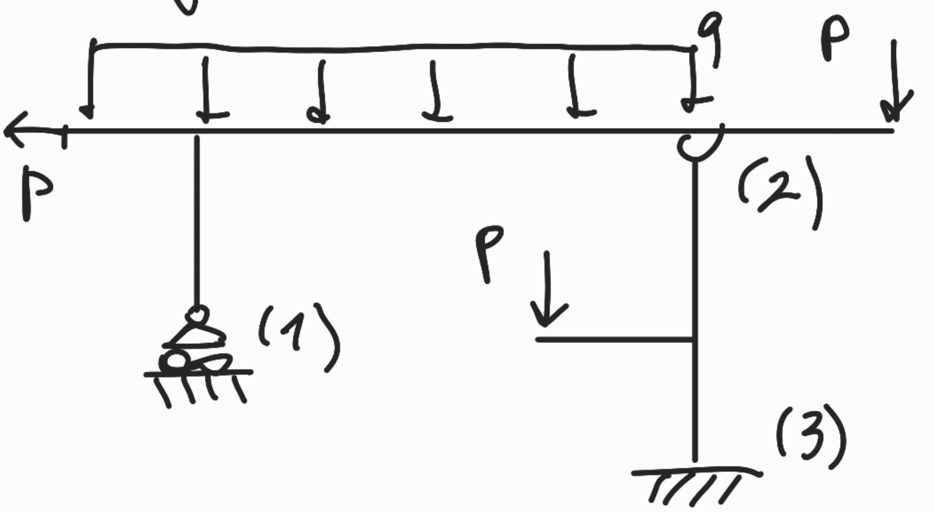
1) • **Verifica che la struttura è isostatica**

$n_{aste} = 2$ $\quad v = 3+2+1 = 6$

$g = 2 \cdot 3 = 6$ $\quad \rightarrow$ isostatica

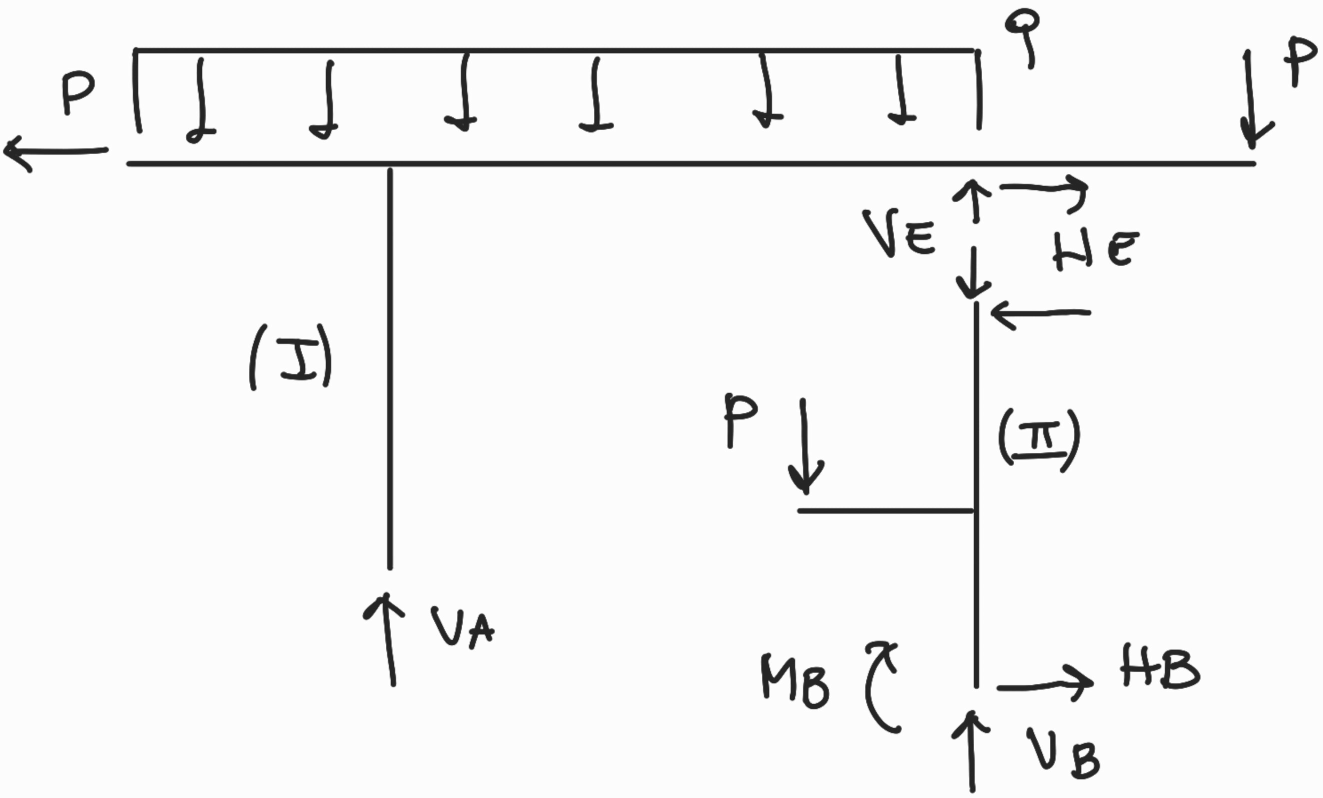


$L = 3\ m$, $h = 4\ m$

$q = 8000\ N/m$

$P = 12000\ N$

• **Calcolo delle reazioni vincolari**



Equilibri delle aste:

I

$$\begin{cases} \overset{+}{\rightarrow} & -P + H_E = 0 \\ \uparrow & V_A - P + V_E - q\frac{5}{2}L = 0 \\ \curvearrowleft_E : & V_A \cdot 2L + PL - q\frac{5}{2}L \cdot \frac{5}{4}L = 0 \end{cases}$$

$H_E = P = 12000\ N$

$V_E = 40500\ N$

$V_A = 31500\ N$

II

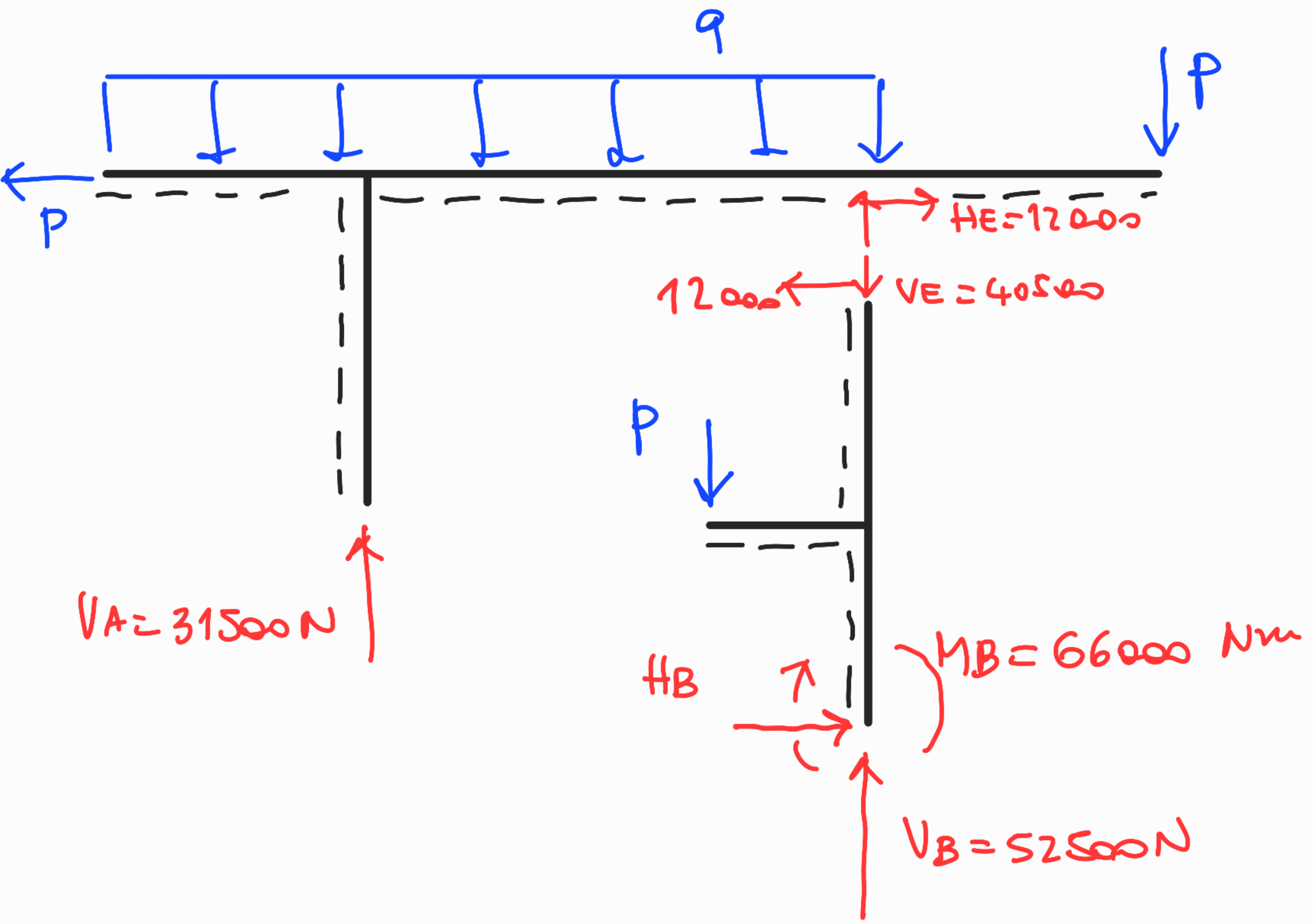
$$\begin{cases} \overset{+}{\rightarrow} & -H_E + H_B = 0 \\ \uparrow & V_B - V_E - P = 0 \\ \curvearrowleft_B : & M_B - P \cdot \frac{L}{2} - H_E \cdot h = 0 \end{cases}$$

$H_B = H_E = 12000\ N$

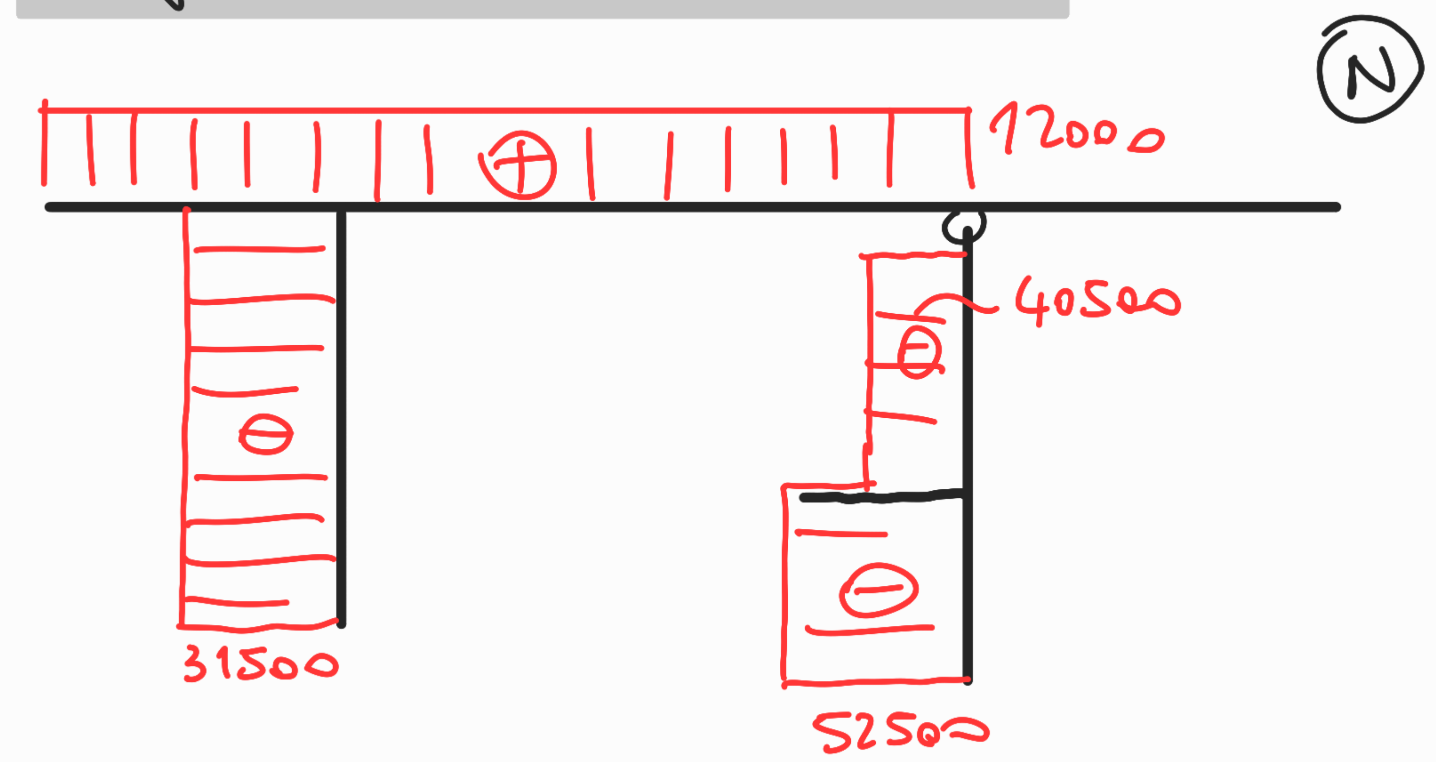
$V_B = 52500\ N$

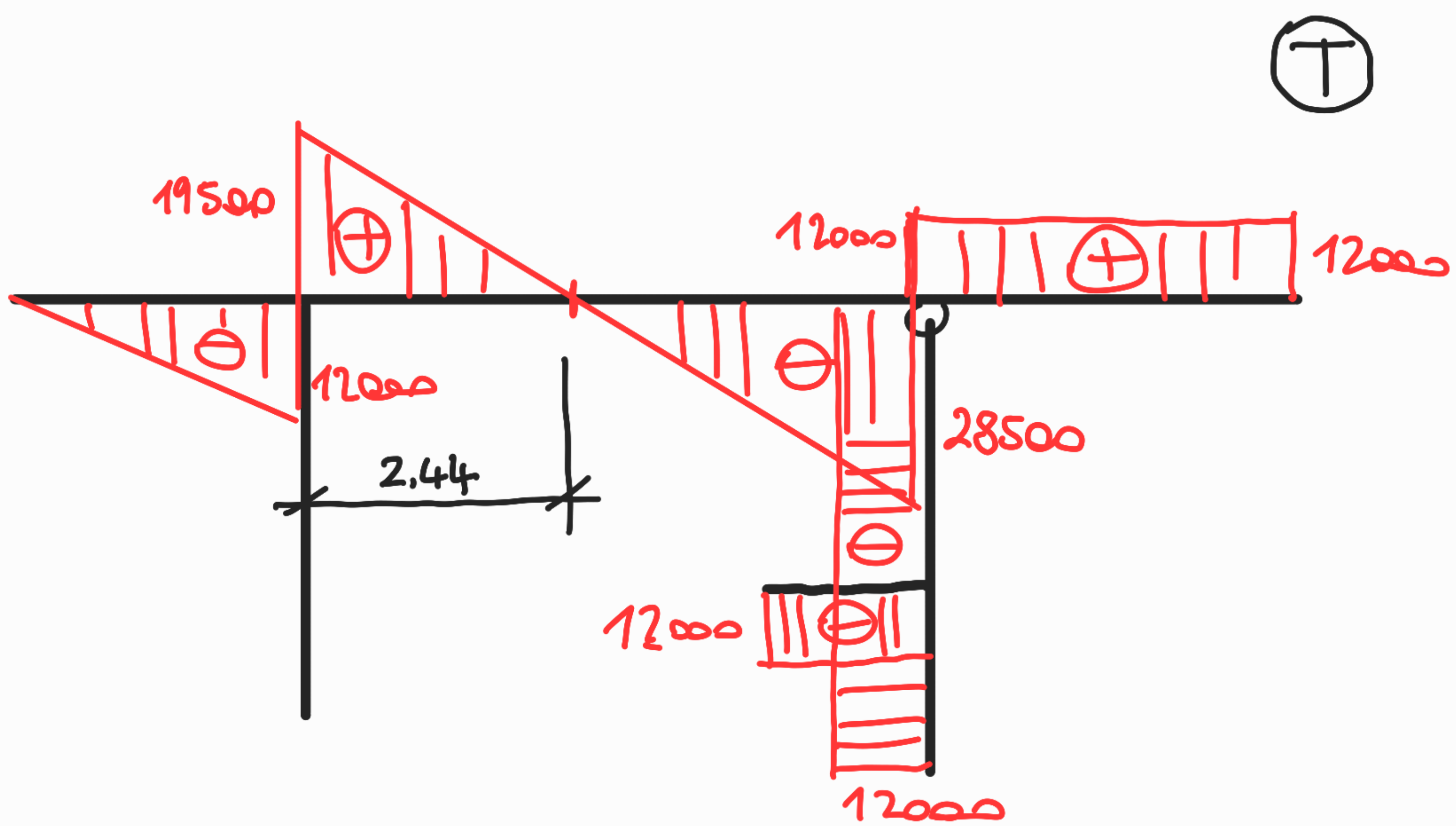
$M_B = 66000\ Nm$

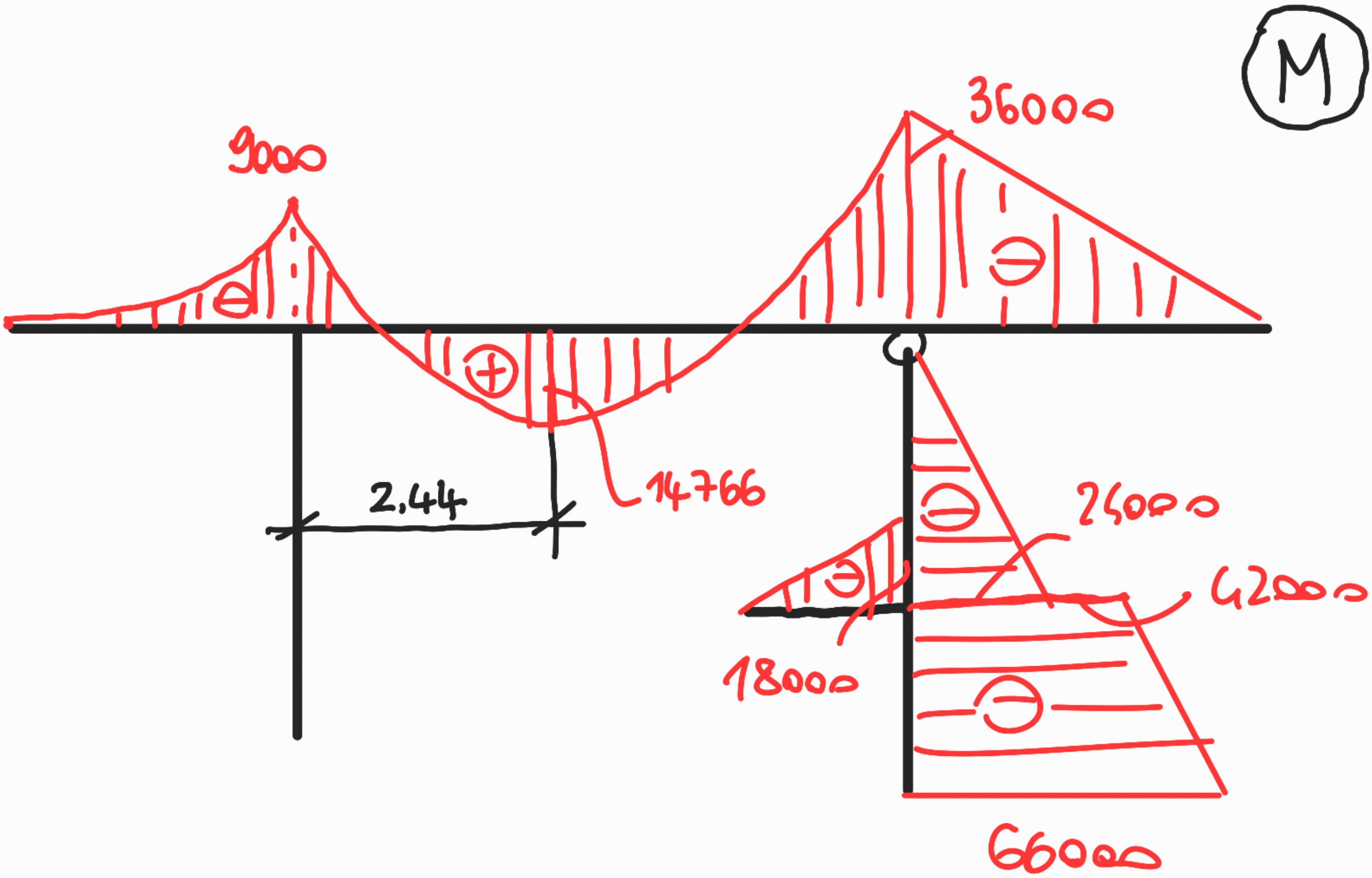
Schema finale delle forze attive e reattive



• Diagrammi delle azioni interne

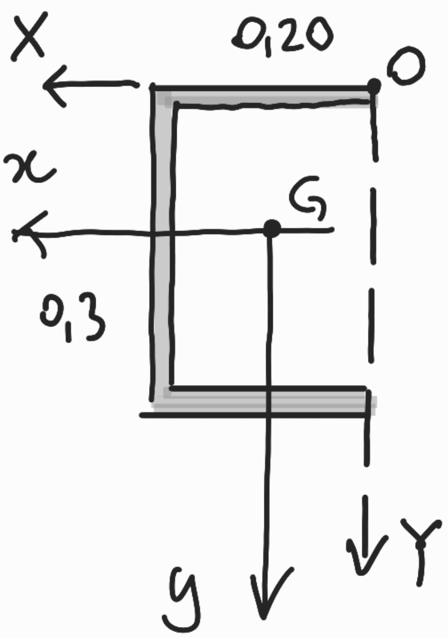






2)

- Caratteristiche geometriche della sezione



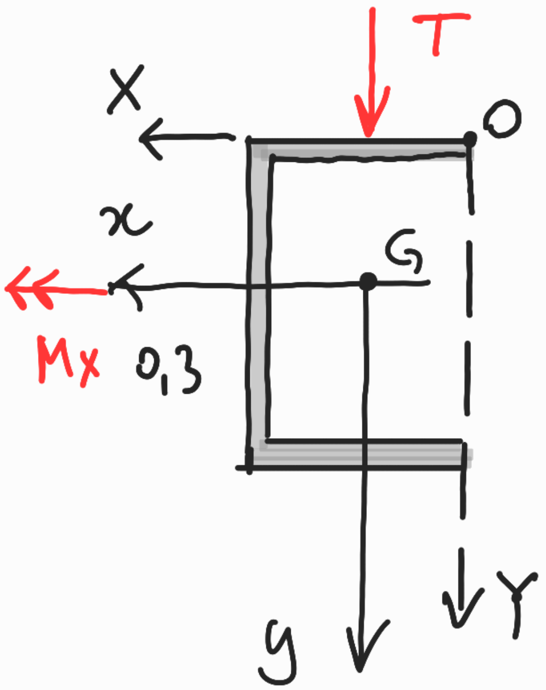
$$A = (0{,}3 + 2 \cdot 0{,}2) \cdot 0{,}01 = 0{,}007\ m^2$$

$$I_x = \frac{0{,}01 \cdot 0{,}3^2}{12} + 0{,}2 \cdot 0{,}01 \cdot 0{,}15^2 \cdot 2 =$$

$$= 1{,}125 \cdot 10^{-4}\ m^4$$

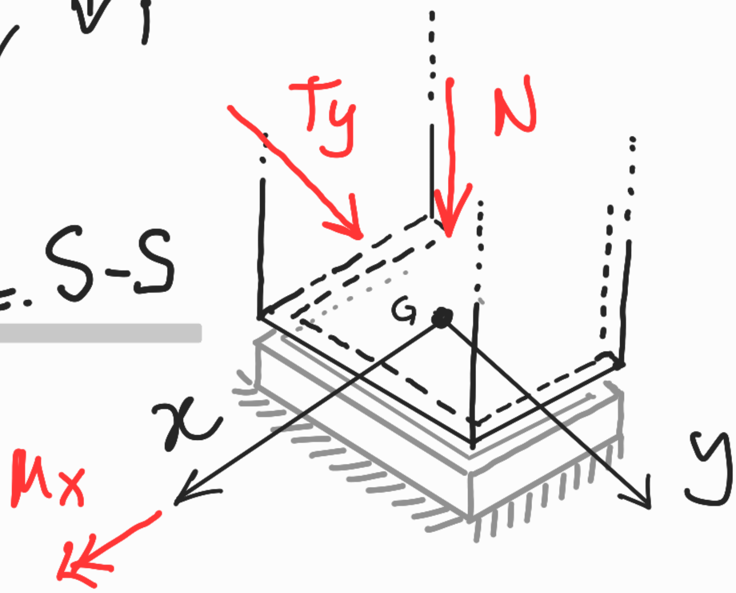
Il momento di inerzia I_y non è necessario.

- **Calcolo delle Tensioni nella sez. S**

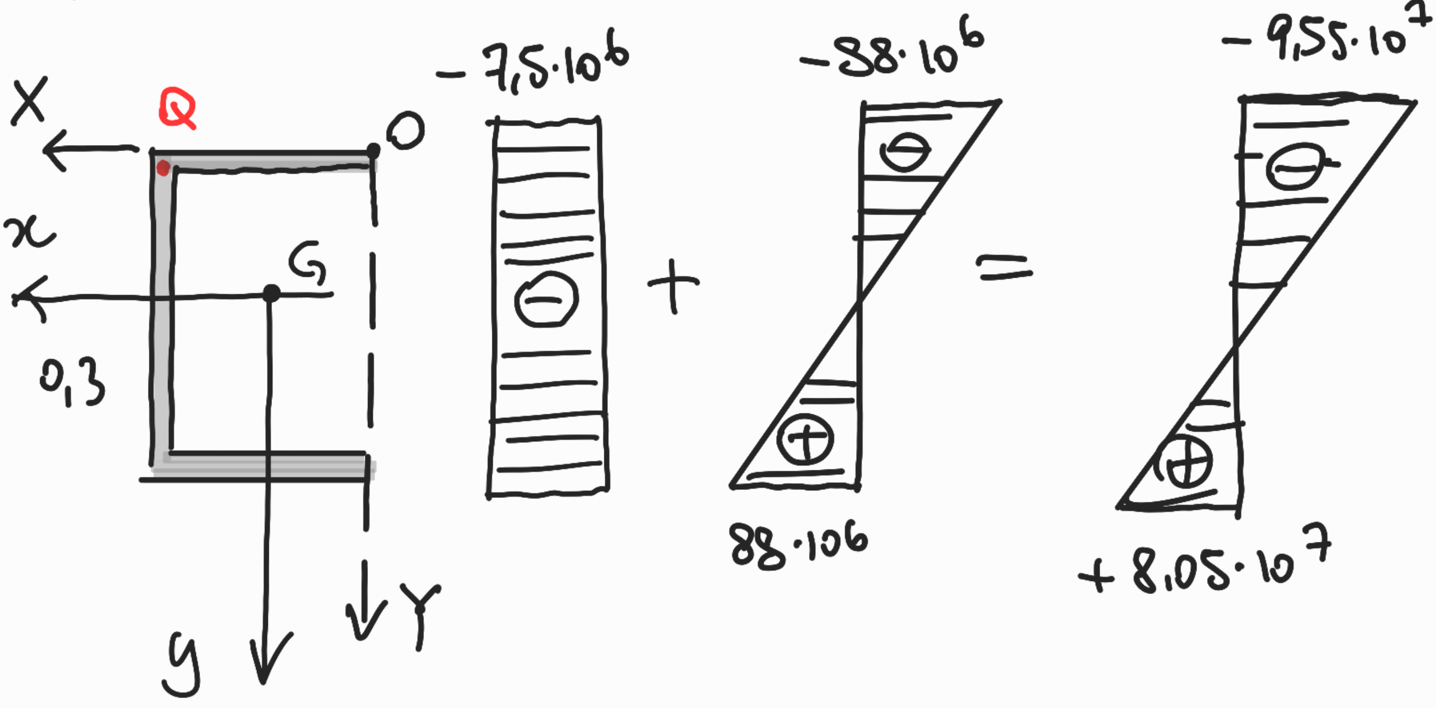


$$\begin{cases} N = -52500 \text{ N} \\ T = 12000 \text{ N} \\ M_x = 66000 \text{ Nm} \end{cases}$$

Sez. S-S



- **Sforzo normale eccentrico**



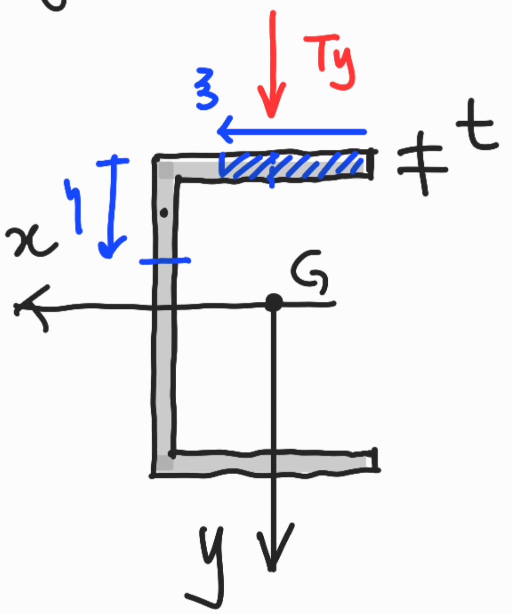
$$\sigma_z(y) = \frac{N}{A} \pm \frac{M_x}{I_x} \cdot y$$

$$= \frac{-12000}{0{,}007} \pm \frac{66000}{1{,}125 \cdot 10^{-4}} \cdot y$$

$$= -7{,}5 \cdot 10^{6} \pm 88 \cdot 10^{7} = \begin{cases} -95{,}5 \text{ MPa} \\ +80{,}5 \text{ MPa} \end{cases}$$

$\sigma_z(Q) = -95{,}5 \text{ MPa}$

- Taglio (f. di Jourawski) $\tau_{zs} = -\dfrac{T_y S_x^*}{I_x \cdot b}$



$$\tau_{zx}(\xi) = -\frac{T_y \cdot \xi t \cdot b/2}{I_x \cdot t}$$

$$\tau_{zx}(\xi=0{,}2) = \frac{+12000 \cdot (0{,}2 \cdot 0{,}01 \cdot 0{,}15)}{1{,}125 \cdot 10^{-4} \cdot 0{,}01} = 3{,}2 \cdot 10^{6} \text{ Pa}$$

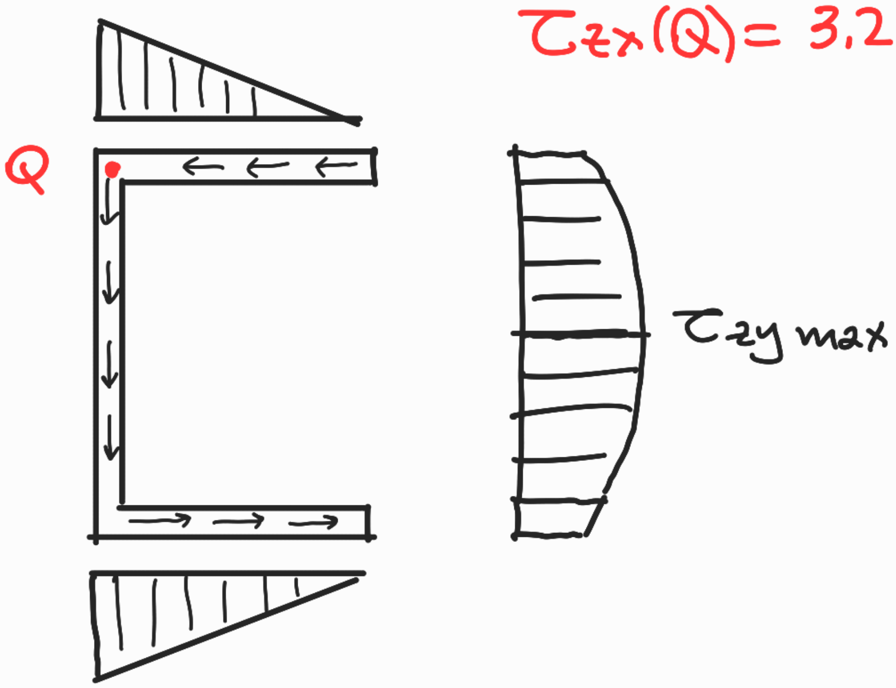
uscente

$$\tau_{zy}(\eta) = -\frac{T_y\left[-0{,}2 \cdot 0{,}01 \cdot 0{,}15 - \eta \cdot 0{,}01 \cdot \left(\frac{b}{2} - \frac{\eta}{2}\right)\right]}{1{,}125 \cdot 10^{-4} \cdot 0{,}01}$$

$$\tau_{zy}(y=0.15) = \frac{+12000 \cdot 4.125\cdot 10^{-4}}{1.125\cdot 10^{-4}\cdot 0.01} = 4.4\cdot 10^{6}\ \text{Pa}$$

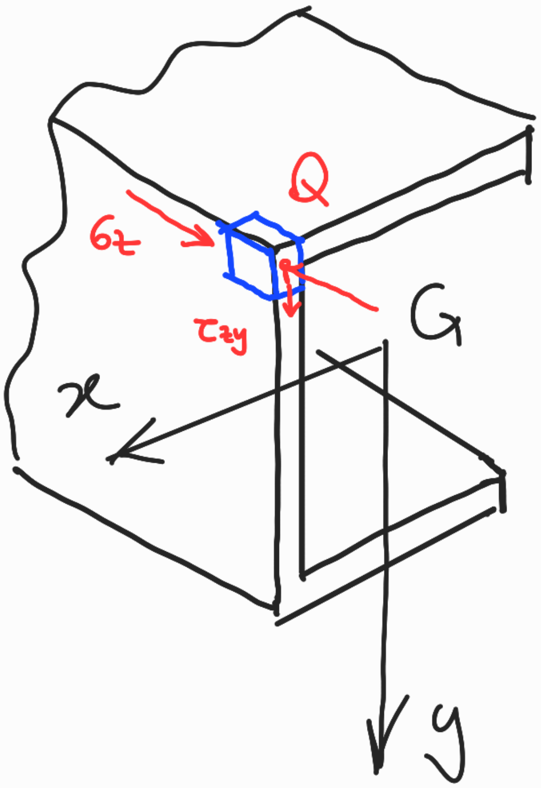
$\tau_{zy\,max}$

$\tau_{zx}(Q) = 3.2\cdot 10^{6}\ \text{Pa}$

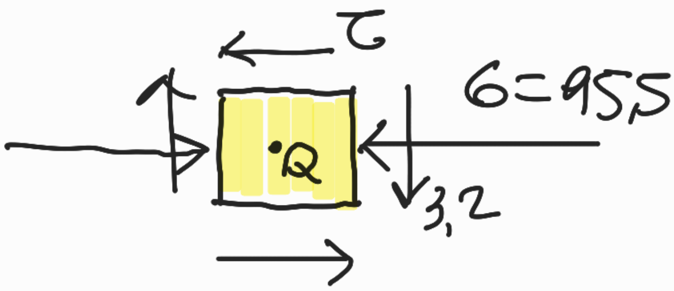


5

• Verifica di resistenza nel punto Q della sez S e cerchio di Mohr

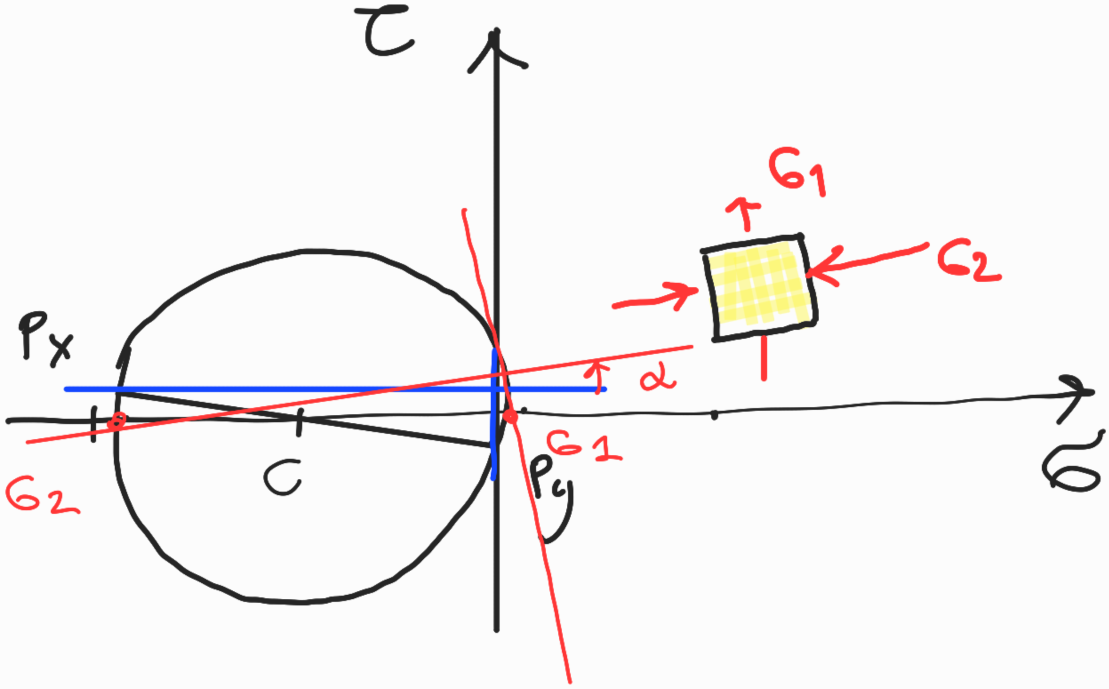


Punto Q (MPa)



$P_x = (-95{,}5 \, ; +3{,}2)$

$P_y = (0 \, ; -3{,}2)$



$x_c = -47{,}75$ MPa $r = 47.86$ MPa

$$\begin{cases} \sigma_1 = x_c + r = 0{,}11 \text{ MPa} \\ \sigma_2 = x_c - r = -95.61 \text{ MPa} \end{cases}$$

$$\alpha = \frac{1}{2} \text{arctg} \frac{\tau_{xy}}{\frac{\sigma_x - \sigma_y}{2}} = +3{,}83^\circ \text{ antiorario}$$

- Verifiche di resistenza

1. Criterio di Von Mises

$$\sigma_{eq.VM} = \sqrt{\sigma^2 + 3\tau^2} = 95{,}66 \text{ MPa} < 160 \text{ MPa}$$

verificato

2. Criterio di Tresca

$$\sigma_{eq.TR} = \sqrt{\sigma^2 + 4\tau^2} = 95{,}71 \text{ MPa} < 160 \text{ MPa}$$

verificato
