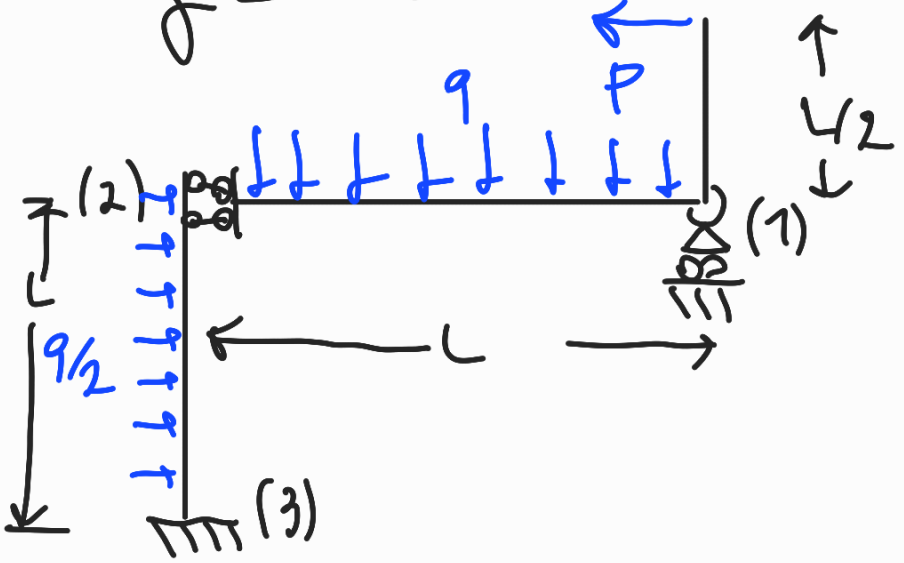
1) • Verifica che la struttura è isostatica

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

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

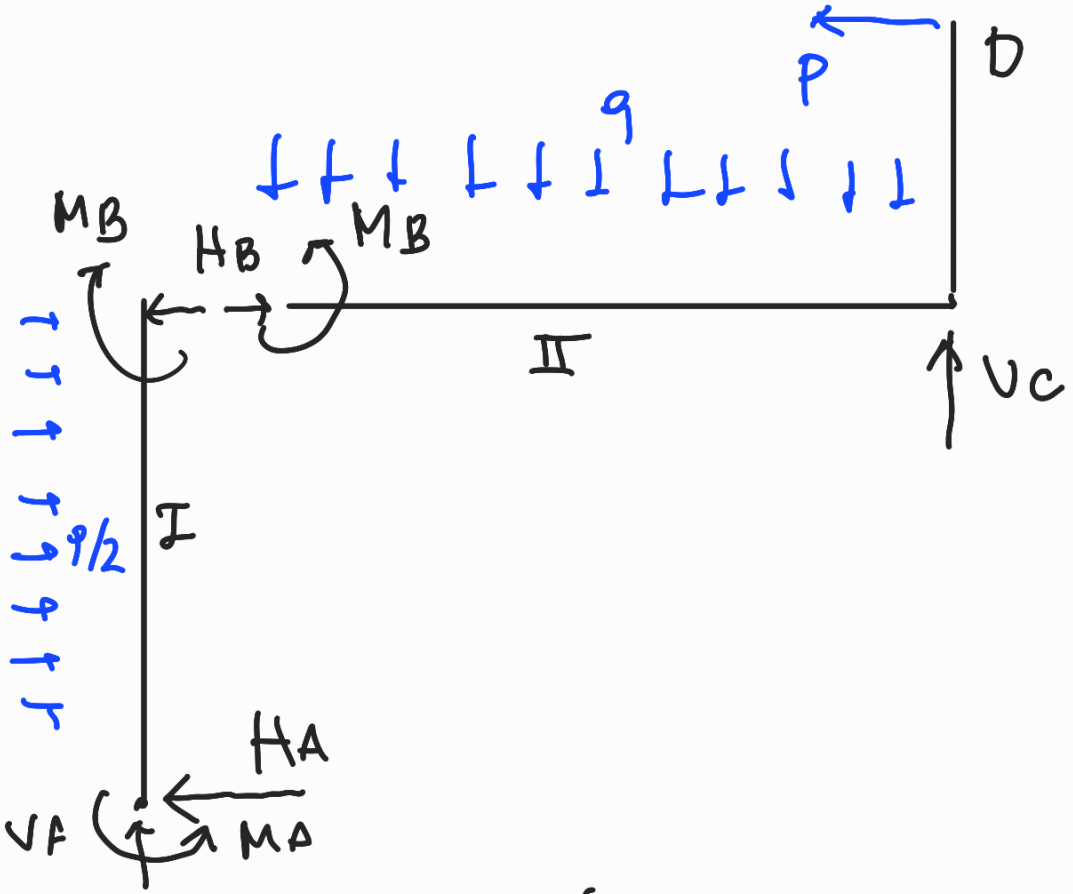


$L = 5\ m$

$P = 15\,000\ N$

$q = 10\,000\ N/m$

• Calcolo delle reazioni vincolari



Equilibri delle aste:

I

$\rightarrow^{+}$ $-H_A - H_B + q\frac{L}{2} = 0$ $\quad H_A = q\frac{L}{2} - H_B = 10000\ N$

$\uparrow$ $V_A = 0$

$\curvearrowright_A$: $M_B - H_B \cdot L + \frac{q}{2}\frac{L^2}{2} - M_A = 0$

II

$\rightarrow^{+}$ $H_B - P = 0$ $\quad H_B = 15\,000\ N$

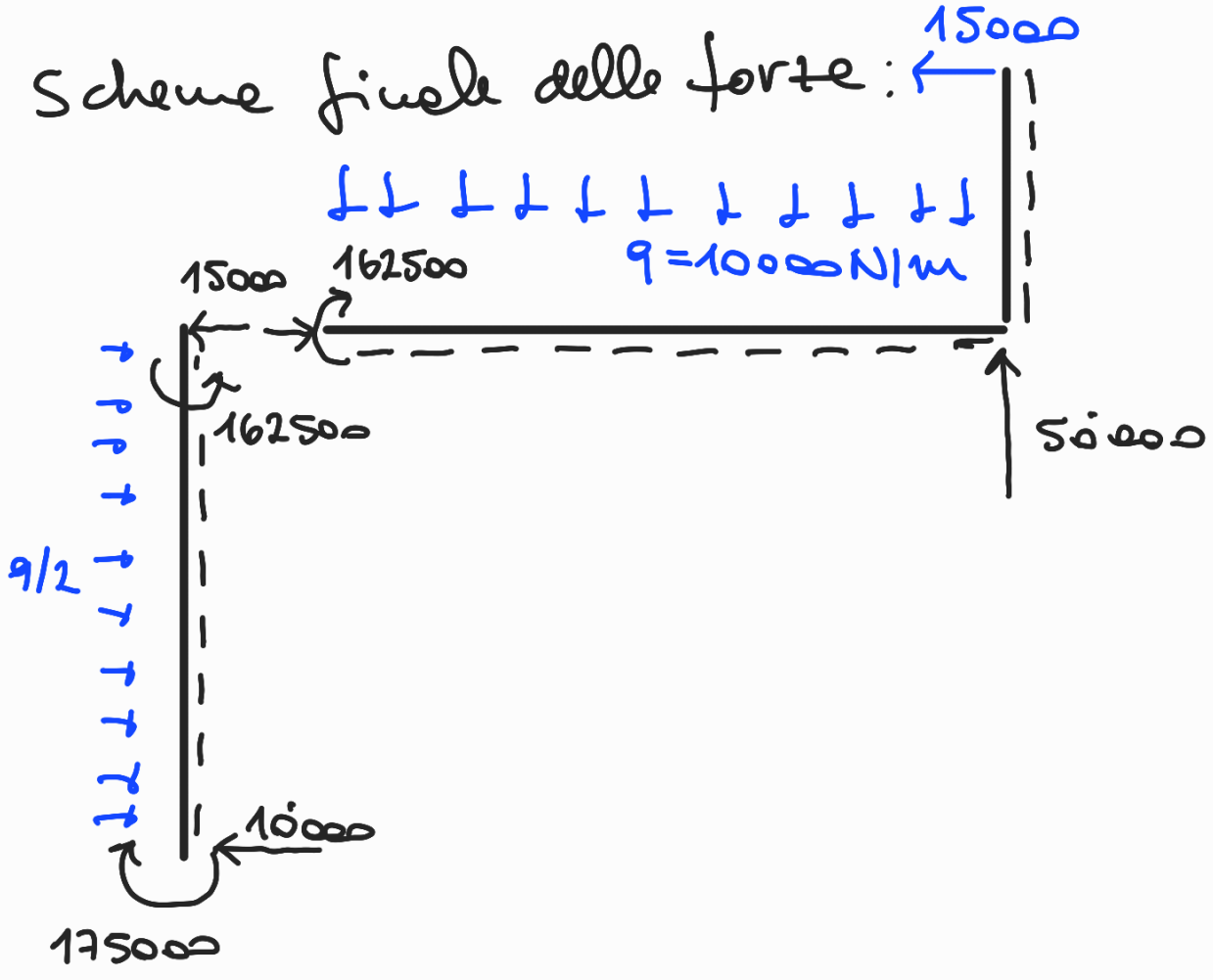
$\uparrow$ $V_C - qL = 0$ $\quad V_C = qL = 50'000\ N$

$\curvearrowright_B$: $-M_B + q\frac{L^2}{2} - V_C \cdot L - \frac{PL}{2} = 0$

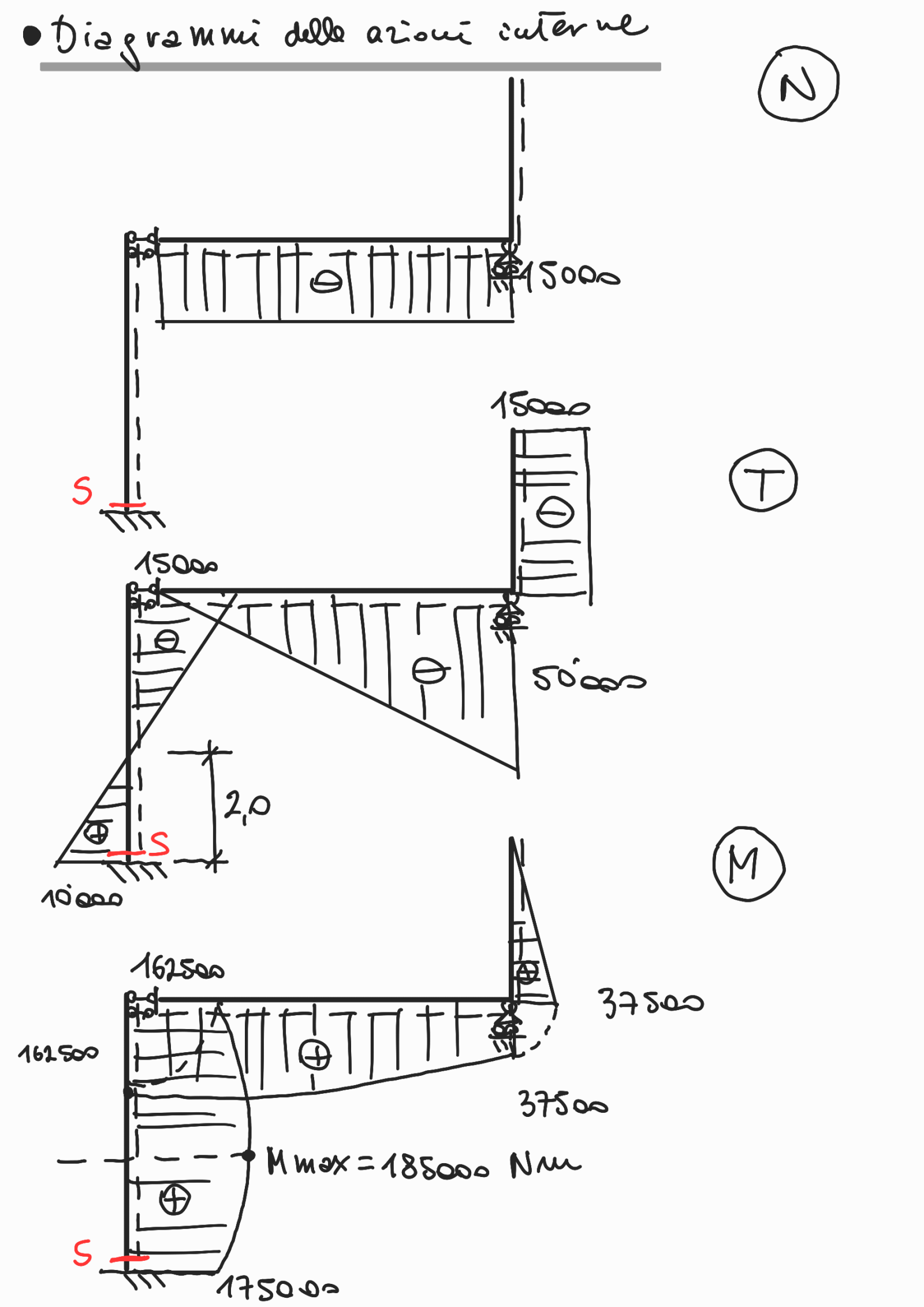
$M_B = q\frac{L^2}{2} - V_C \cdot L - \frac{PL}{2} = -162\,500\ Nm$

$M_A = M_B - H_B \cdot L + q\frac{L^2}{4} = -175\,000\ Nm$

Schema finale delle forze:

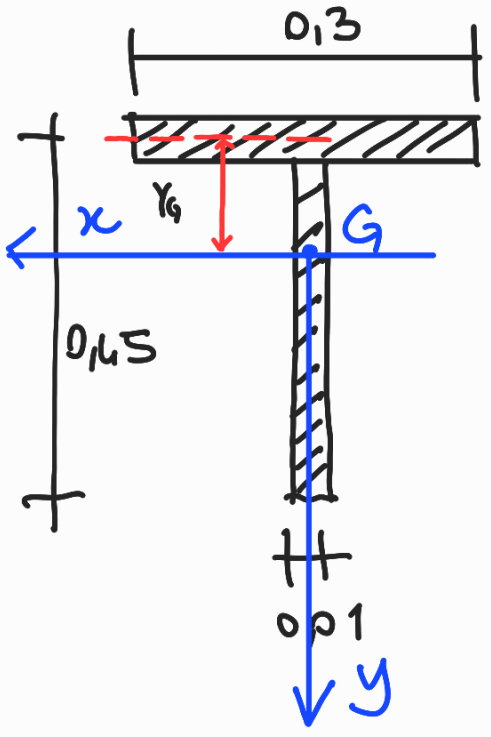


• Diagrammi delle azioni interne



2)

- Caratteristiche geometriche della sezione



$$A = 0{,}3 \cdot 0{,}02 + 0{,}45 \cdot 0{,}01 = 0{,}0105\,m^2$$

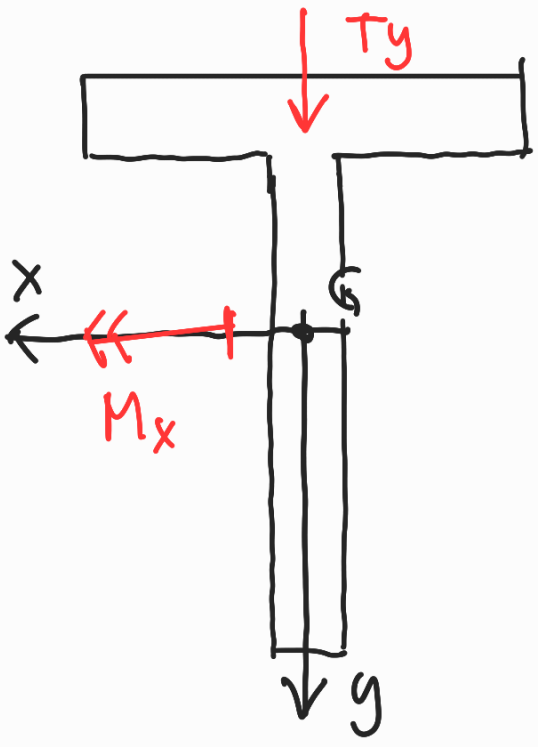
$$y_G = \left(0{,}45 \cdot 0{,}01 \cdot \frac{0{,}45}{2} + 0\right) / A = 0{,}096\,m$$

$$I_x = \left[\frac{0{,}3 \cdot 0{,}02^3}{12} + 0{,}3 \cdot 0{,}02 \cdot 0{,}096^2\right] + \left[\frac{0{,}01 \cdot 0{,}45^3}{12} + 0{,}45 \cdot 0{,}01 \cdot \left(\frac{0{,}45}{2} - 0{,}096\right)^2\right]$$

$$= 5{,}55 \cdot 10^{-5} + 1{,}51 \cdot 10^{-4} = 2{,}06 \cdot 10^{-4}\,m^4$$

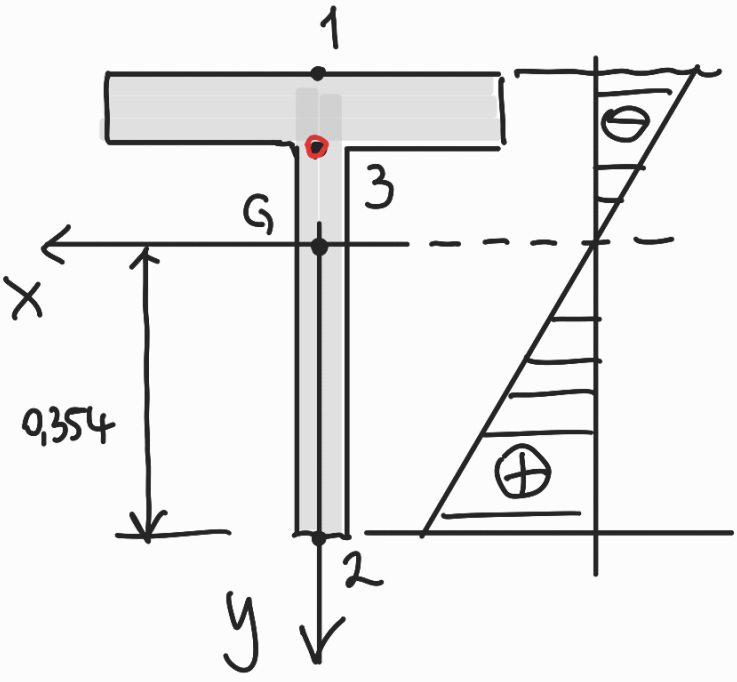
Il momento di inerzia I_y non è necessario.

• Calcolo delle Tensioni nella sez. S



$$\begin{cases} N = 0 \\ T_y = 10'000\ N \\ M_x = 175000\ N\,m \end{cases}$$

- Flessione retta



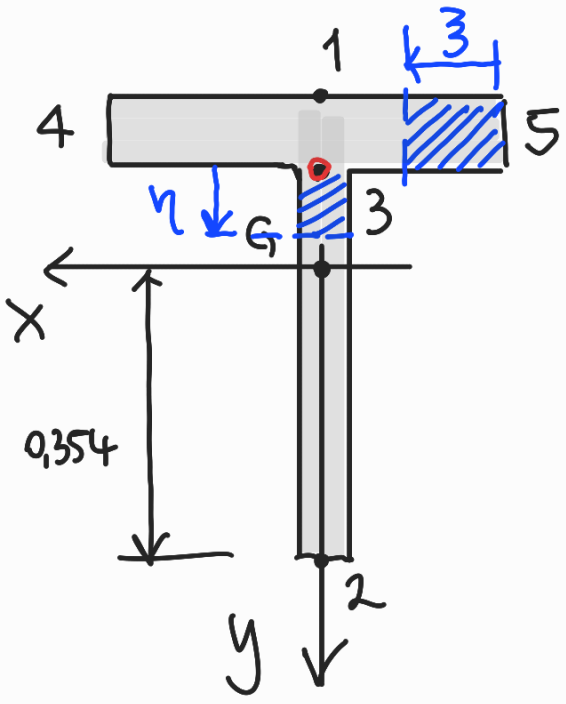
$$\sigma_z(y) = \frac{M_x}{I_x} \cdot y$$

$$\sigma_z^{(2)} = \frac{175000}{2,06 \cdot 10^{-4}} \cdot 0,354 = 300\ MPa$$

$$\sigma_z^{(1)} = \frac{175000}{2,06 \cdot 10^{-4}} (-0,096) = -81,5\ MPa$$

$$\sigma_z^{(3)} = \frac{175000}{2,06 \cdot 10^{-4}} \cdot (-0,096 + 0,01) = -73\ MPa$$

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



Tratto 1-5

$$S_x^*(\zeta) = 0{,}02 \cdot \zeta \cdot (-0{,}096)$$

$$\tau_{zx}^{(1)} = \frac{-0{,}02 \cdot 0{,}15 \cdot (-0{,}096) \cdot T_y}{I_x \cdot 0{,}02}$$

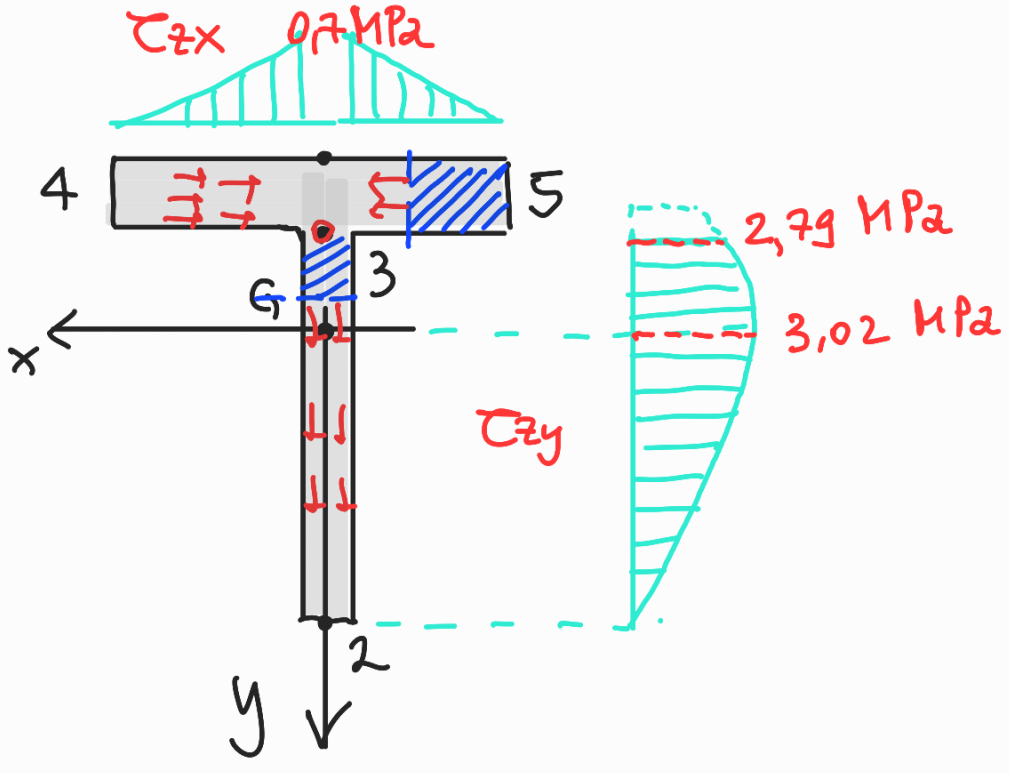
$$= 0{,}7 \text{ MPa (uscente)}$$

Tratto 2-3

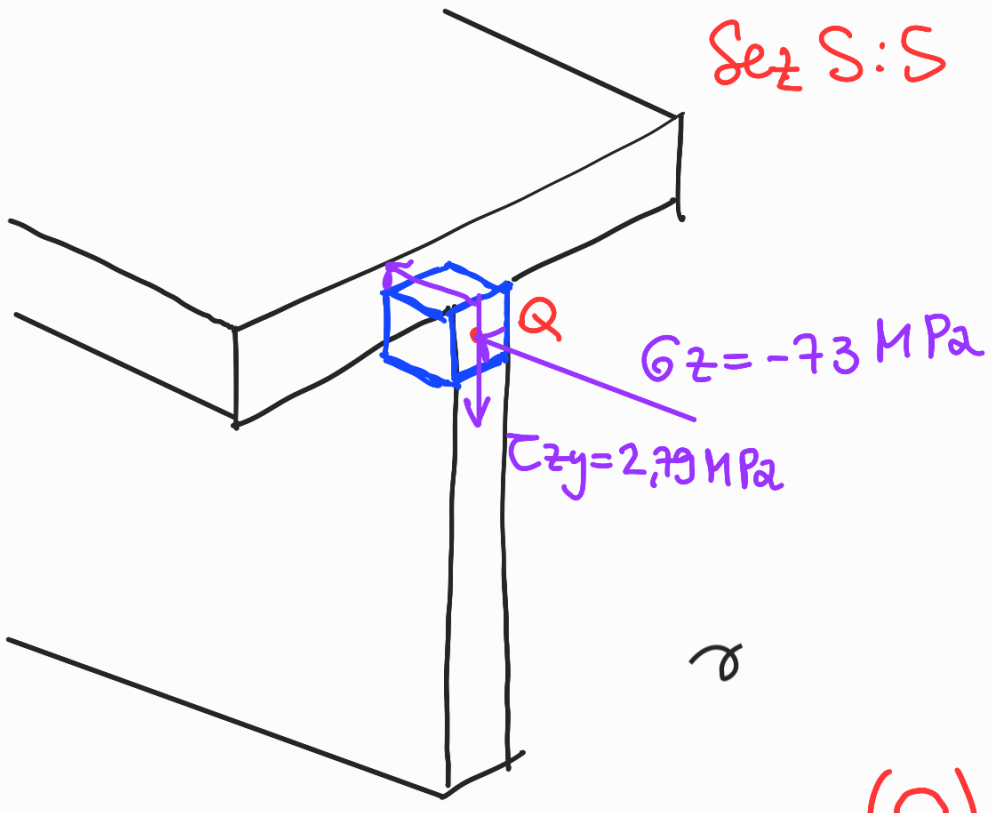
$$S_x^*(\eta) = 0{,}3 \cdot 0{,}02 \cdot (-0{,}096) + \left(0{,}01 \cdot \eta \cdot \left(-0{,}096 - \frac{\eta}{2}\right)\right)$$

$$\tau_{zy}(\eta = 0{,}096) = -\frac{10000 \cdot (-6{,}27 \cdot 10^{-4})}{2{,}06 \cdot 10^{-4} \cdot 0{,}01} = 3{,}02 \text{ MPa}$$

$$\tau_{zy}(\eta = 0) = -\frac{10000 \left(0{,}3 \cdot 0{,}02 \cdot (-0{,}096)\right)}{2{,}06 \cdot 10^{-4} \cdot 0{,}01} = 2{,}79 \text{ MPa}$$

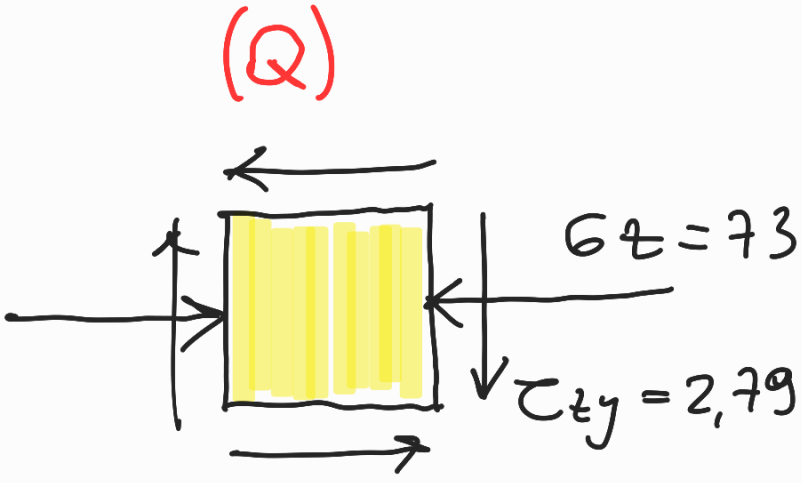


- Verifica di resistenza nel punto Q della sez S e cerchio di Mohr

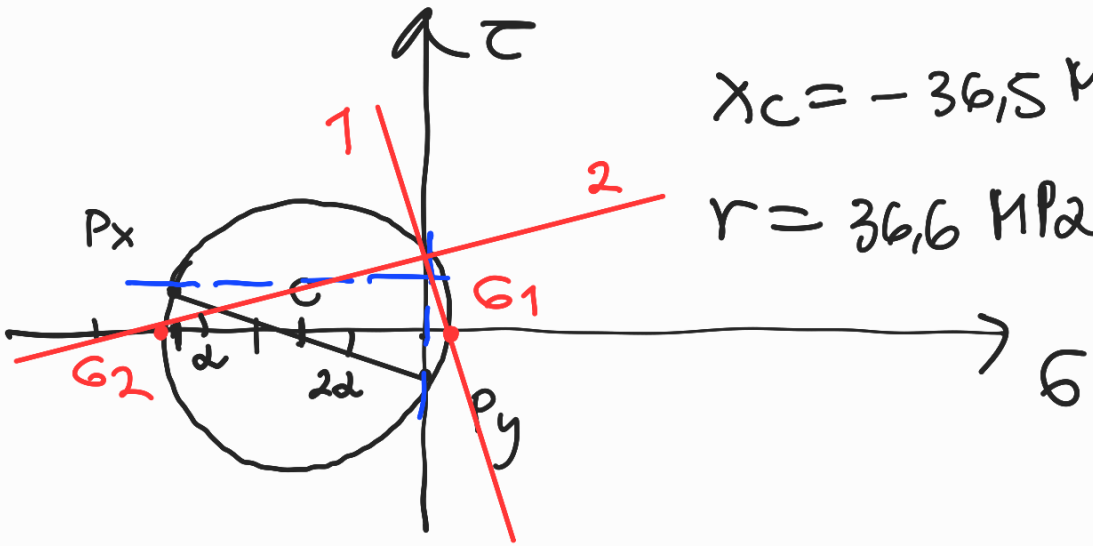


$P_x = (-73 ; 2{,}79)$

$P_y = (0 ; -2{,}79)$



Cerchio di Mohr nel punto Q

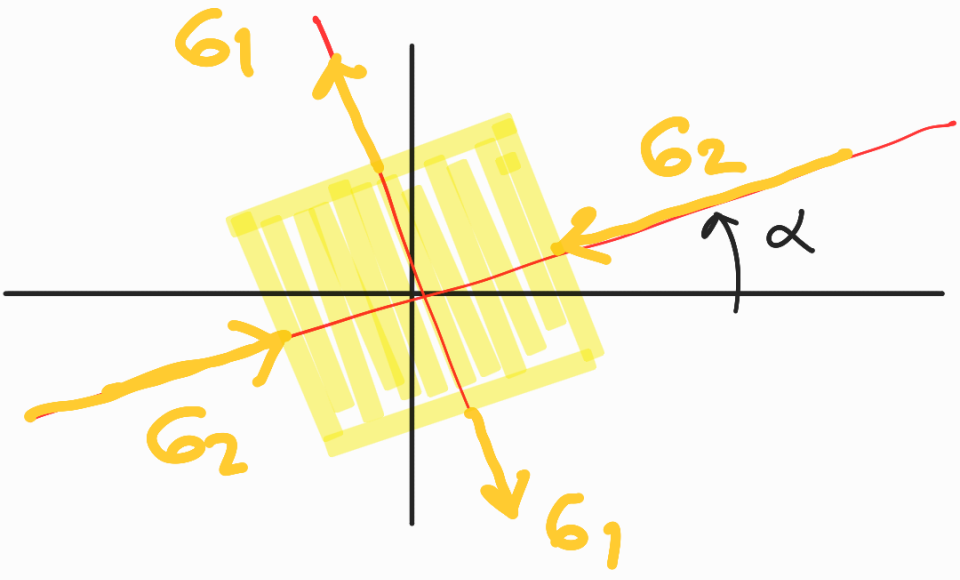


$x_C = -36{,}5$ MPa

$r = 36{,}6$ MPa

$\sigma_1 = x_c + r = 0{,}1$ MPa (*) $\alpha = 2°{,}35$ ↑

$\sigma_2 = x_c - r = -73{,}21$ MPa



$\sigma_{t,amm} = 1$ MPa

$\sigma_{c,amm} = 10$ MPa

Verifica di resistenza (cit. di Rankine)

$\sigma_1 = 0{,}1 < \sigma_{t,amm}$ verificato

$\sigma_2 = |-73{,}21| > \sigma_{c,amm}$ non verificato

(*)
$$\alpha = \frac{1}{2}\,\text{arctg}\,\frac{-2\tau_{xy}}{\sigma_x - \sigma_y} = \overset{+}{2°{,}35}$$ antiorario